ACKNOWLEDGEMENTS

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ABSTRACT

A six month sampling program was conducted on a segment of the Ottawa River to examine micro-invertebrates. Of eight invertebrate phyla represented, Arthropoda were the most abundant, and in particular Cladocera. The cladocerans collected included 45 species in 27 genera which accounts for approximately 60 percent of the known species for Ontario.

Using species abundance and species frequency data the cladoceran communities of four different habitats within the Ottawa River were compared. The backwater bay habitat was found to contain mainly planktonic Cladocera while all other habitats examined contained varying combinations of benthic and planktonic Cladocera.

Seasonal abundance within the study area was most apparent within the Kettle Island backwater bay where numbers were observed to follow the production pattern most characteristic of lakes. At all other sites, except the mid-river stations, cladoceran abundance appeared to be influenced by macrophytic vegetation.

INTRODUCTION

In 1971 the National Research Council of Canada in conjunction with the University of Ottawa, established a five year multi-disciplinary program to examine persistent chemical dynamics within a segment of the Ottawa River. Food chain uptake was singled out for special attention.

Previous investigators had been concerned primarily with the chemical assessment of water quality in the Ottawa River (Thomas, 1952; Piche, 1954; Barrens, 1961; Le Sauteur, 1965). Mackie's (1972) work dealt with the benthic and attached invertebrates as did Owen's survey (1972). No systematic studies of zooplankton in this section of the Ottawa River has ever been made to the best of my knowledge.

Morry et al (1973) examined the microcrustacea of the nearby Gatineau Park lakes. Some of the species they recorded were also found in the Ottawa River.

Zooplankton studies on rivers have, in the past, been mainly designed around a mid-river sampling program. Such investigations have been involved with examining the fate o of plankton discharges from lakes or reservoirs (Brook and Woodward, 1956; Reif, 1939) or examining representative sites along the drainage course of a particular river (Green, 1962; Holden and Green, 1960; Hutchinson, 1933; Brinley and Katzin, 1942; Kussat, 1969; Prins and Davis, 1966; Tan, 1970).

Although it is well recognized that many lake plankton species have general habitat preferences, no such data exists for river dwelling species. Various researchers have studied lake plankton forms as they progressed downstream (Galtsoff, 1924; Eddy, 1932). Other authors have reported the occurrences of potamoplankton in flowing water ecosystems (Rzoska _et al_, 1955; Kofoid, 1908). As defined by Ruttner (1963) potamoplankton refers to the 'true' stream plankton in large rivers, which forms its own community independent of tributaries and floodplain waters.

Typically creeks carry only lake plankton and produce no true plankton of their own, (Badcock, 1950; Badcock, 1954; Reif, 1939). Rivers, on the other hand, are capable of maintaining a reproducing zooplankton population. (Kofoid, 1908; Eddy, 1932; Ertl, 1966). Kofoid (1908) has shown that the shallower waters of flowing systems were generating a supply of plankton within the system. Ertl (1966) examined zooplankton populations in backwater bays of the Danube River where he found a marked similarity in population composition to those found in nearby ponds.

Due to its geographic disposition, the NRC - University of Ottawa study area lends itself to a habitat analyses. Within the study area four different habitats were identified and differences between these habitats were investigated.

This study had three basic objectives. 1) to identify the species (or taxa) of micro-invertebrates within the Ottawa River study area; 2) to identify the variation in density occurring between the four habitats within the study area, and 3) to quantify the temporal variation occurring within the river section. These objectives were aimed at providing data needed for the co-operative University of Ottawa - National Research Council of Canada Ottawa River Project.

METHODS AND MATERIALS

1. SAMPLING AREA

All sampling sites were within a 3.2 kilometer (2 mile) section of the Ottawa River near Ottawa, Ontario, Canada (Lat. 45° 25'N and Long. 75°42'W). The sampling area on the Ottawa River is indicated in Figure 1 and specific site locations are shown in Figure 2.

2. FIELD SAMPLING PROCEDURES

A total of 370 samples were collected during the period 13 May 1972 - 29 October 1972. The sampling sites were arbitrarily divided into three series.

All samples were taken with a Wisconsin style plankton net. Two nets were used over the course of the sampling period. Net One was used until 8 July, 1972. While on loan it was damaged and had to be repaired. For the remainder of the sampling season the stand-by net, Net Two, was used.

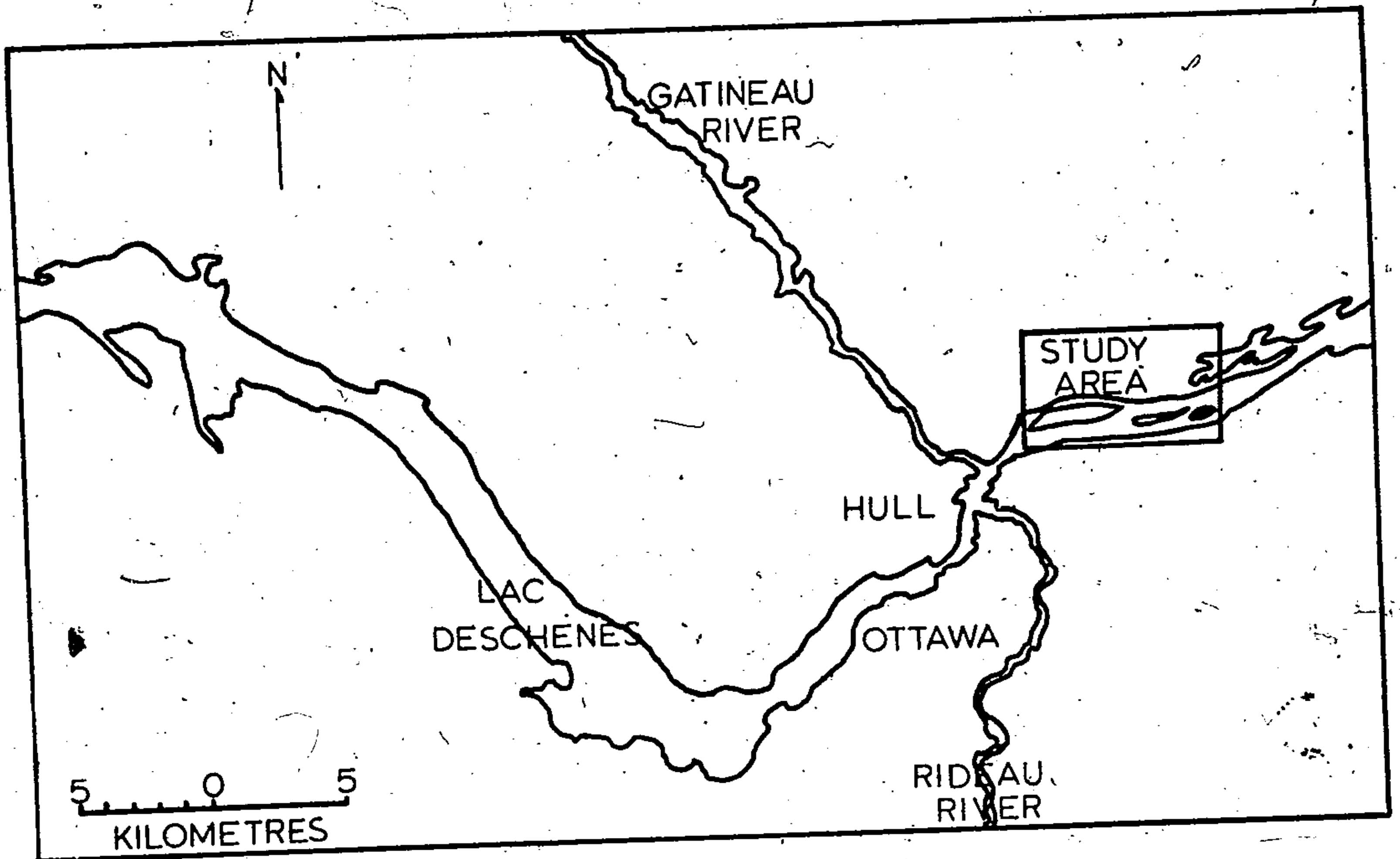
Net One had a mouth diameter of 30 centimeters, a mouth to bucket length of 110 centimeters, and was of 76μ mesh. A Gemware Precision Instrument Company flowmeter (Model No. 005WA200) was mounted in the mouth of the net. Net Two was similar, but larger. It had a mouth diameter of 50 centimeters, a mouth to bucket length of 145 centimeters, and was of 82μ mesh. Net Two was equipped with a General Oceanics Incorporated flowmeter (Model No.2030).

Early in the sampling season a tube sampler, model-

38

Figure 1

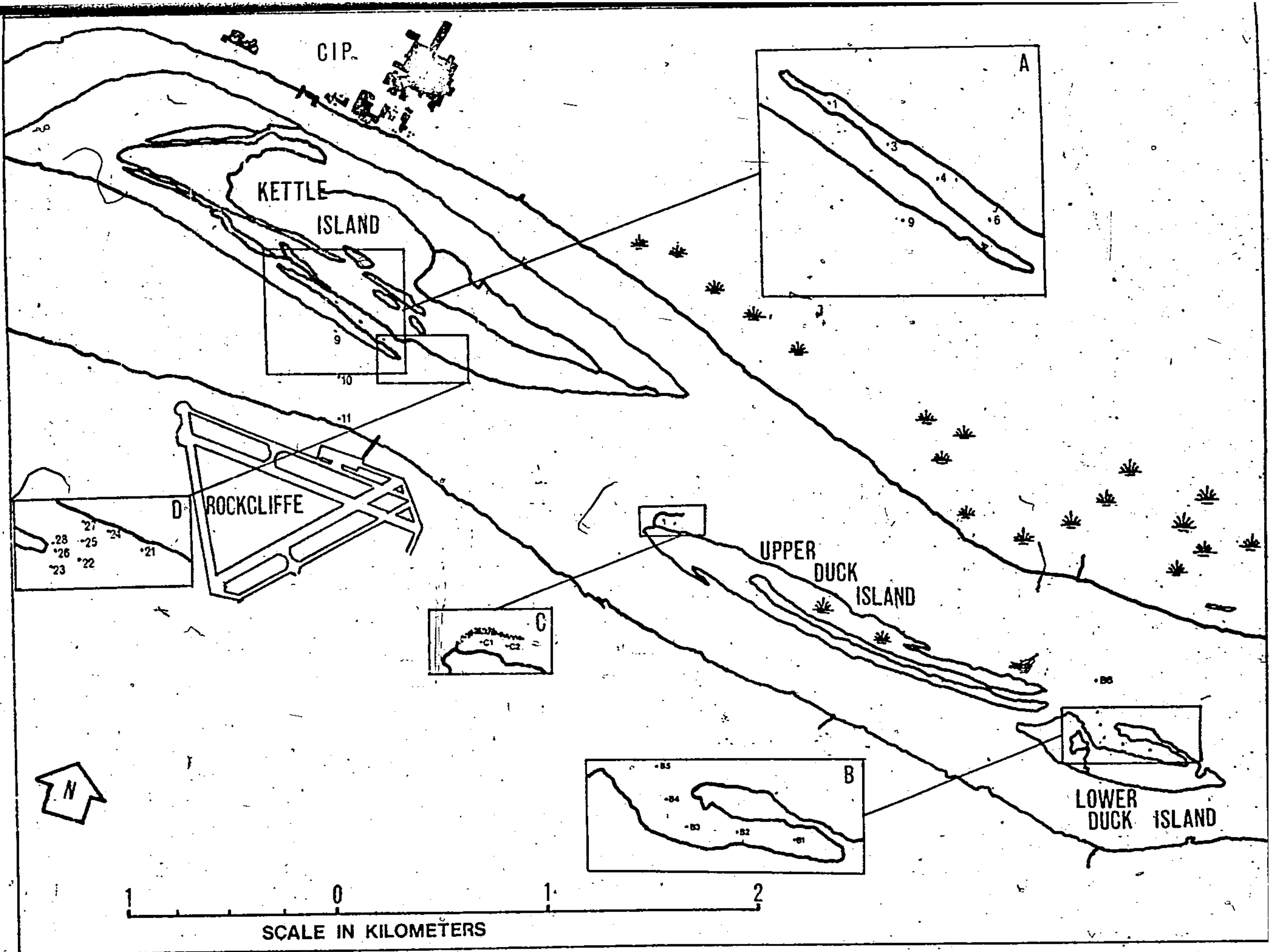
Location of the study area on the Ottawa River. (arrow indicates direction of flow)



N
GATINEAU RIVER
STUDY AREA
HULL
LAC DESCHENES
OTTAWA
RIDEAU RIVER
5 0 5
KILOMETRES

Figure 2

Study area on the Ottawa River with inserts to illustrate location of sampling stations.


CIP
KETTLE ISLAND
A
1
3
4
6
9
10
11
D
ROCKCLIFFE
27
28
25
24
26
21
22
23
C
C1
C2
UPPER DUCK ISLAND
B6
B
B5
B4
B3
B2
B1
LOWER DUCK ISLAND
N
1
0
1
2
SCALE IN KILOMETERS

led after those of Pennak (1957) and Applegate et al (1968) was developed for use. This sampler was composed of a six foot fpiece of PVC plastic pipe with a 3.5 inch inside diameter. A tightly fitting wooden plug was made for one end. The sampling procedure involved lowering the tube into the water to the desired depth, usually several inches from the bottom, placing the wooden plug in the upper end, and then lifting the tube vertically from the water. A fine mesh plankton net was then placed under the lower end, the plug removed, and the sample thus filtered. Although this gear proved to have several advantages for sampling in shallow water, as outlined by Pennak (1957), the volume of water filtered was too small to realize statistically significant quantities of zooplankton.

The sampling procedures used for vertical hauls involved the lowering of a plankton net to the bottom, then pulling it to the surface in a vertical plane. At the surface, the net was rinsed to concentrate the sample in the bucket. The sample was then transferred to a jar and formaldehyde was added to bring the sample to a final concentration of ten percent formalin. Before replacing the plankton bucket, the net was rinsed to ensure that it was as clean as possible before further samples were taken.

2.1 SERIES A STATIONS

Those stations located within the Kettle Island backwater bay and adjacent to the bay in the main river channel were included in Series A (Figure 2, Insert A).

The statinns within the series A group were from three areas. Area one includes all stations within the Kettle Island Bay. Stations so included are one, three, four, and six. Vertical haul samples were taken at each station. Samples two and five were surface horizontal hauls with two taken from station one to station three and five taken from station four to station six. The four stations were positioned along a linear transect at approximate intervals of 160 meters. Station one, deepest in the bay, was equidistant between the source of the bay and station three.

Area two included stations seven and eight, which were located in the mouth of the bay outside the main basin of the bay. Vertical hauls were taken at both stations.

Area three included stations nine, ten, and eleven, all within the main river channel. Station nine was located outside the bay, in shallow water, and on the south side of Kettle Island. Station ten was a mid-river site between Kettle Island and the Rockcliffe Air Base dock. Station eleven was upstream from the Rockcliffe Air Base dock and near shore. By design, station ten was located midway between stations nine and eleven, with nine and eleven being equidistant from shore on opposing sides of the main channel. Vertical hauls were taken at all three stations.

Sampling of the series A pattern was initiated 13 May 1972 and continued at a regular ten day interval where possible, until 19 October 1972.

2.2 SERIES B STATIONS

The stations of series B were those of the Duck Islands. These stations were divided into two groups - one group in the Lower Duck Island Bay area and the other group at the upstream end of Upper Duck Island, (Figure 2, Inserts B and C).

Stations B1 through B4 were all located within the Lower Duck Island Bay proper. Station B5 was located at the junction of the river channel and Lower Duck Island Bay, while B6 was located in the main river channel adjacent to the bay (Figure 2). All stations were located at 100 meter intervals except station B6, which was approximately 150 meters from station B5. Vertical hauls were taken at all stations while horizontal hauls were taken between stations B1 and B2, and between B3 and B4.

The second group of stations within the B series were the Upper Duck Island stations, C1 and C2. These stations were located 75 meters apart and at equal distances from shore. In early Spring, these stations appeared in the main river channel but as the aquatic vegetation developed they became embayed by macrophytic growth. Vertical hauls were taken at both stations C1 and C2 and a horizontal haul was taken from C1 to C2.

The B Series pattern was first sampled 19 June 1972, and at a ten day interval, continued until 29 October 1972.

2.3 SERIES C

The C Series stations were those in the downstream mouth area of the Kettle Island Backwater Bay (Figure 2, Insert D). The purpose of this series of stations was for examination of differences in micro-crustacea occurring with increased distances from the Kettle Island Bay.

The stations, 21 to 28 inclusive, were a combination of shallow water and deep water sites. In all cases, vertical hauls were taken at the individual stations and surface horizontal hauls were taken between stations.

As the stations of this habitat were not from a clearly defined geographic basin a regular sampling program was not used for this series. The series was sampled periodically through July, August, and September.

3. WATER ANALYSIS AND MORPHOMETRY

Temperature and conductivity measurements were taken monthly at all stations except those of the C Series. A YSI (Yellow Springs Instrument Company) Salinity-Conductivity-Temperature meter (Model No. 35) was used. Transparency was measured with a 20.3 centimeter (8.0 inch) diameter secchi disc. Depth soundings were taken with a Fis-Lo-K-ToR (sonar device) in the Kettle Island Bay. At the other sites, a hand line was used to measure depths.

4. LAB ANALYSIS

Laboratory procedures consisted of two phases, sorting and identification.

In sorting, five milliliter aliquots were taken out of the sample for identification. The actual subsample size varied between five and ten percent of the total sample, depending upon the concentration of organisms within the sample.

Although this was a relatively standard sub-sampling procedure, it had limitations. The primary limitation was its failure to consistently record low density species in numbers comparable to their concentration in the original sample. To overcome this inconsistency, the sorting procedure was modified. A sub-sample was examined for high density species. The sample was then allowed to settle for at least one hour, the supernatent poured off, and the total settled residue was then examined for the presence of the rarer species. This modified sub-sampling procedure, somewhat similar to that proposed by Allanson and Kerrich (1961) was felt to give the best results as it permitted the greatest accuracy in estimating low density species.

All organisms were sorted to major taxa under a dissecting microscope (X20) and transferrred to vials containing five percent formaldehyde.

A series of permanent mounts were made on glass microscope slides during the course of the sample analysis. These acted as reference specimens for subsequent identifications.

The procedure used was modified from that of Owre and Foyo (1967).

A drop of polyvinyl lactophenol was placed on a pre-cleaned slide. Using a dissecting probe, a small drop of Turtox CMC-S non-resinous stain-mountant (General Biological Supply House, Chicago) was then transferred to the medium and stirred in until a very slight pink was observed. The slide was then left under a bright light for approximately two minutes to allow the bubbles to escape. A single specimen was then transferred from the sample to the mounting medium, a cover slip added, and the slide put aside for 15 minutes before examination under a light microscope. Several days later, when the medium had hardened, the cover slip was sealed by ringing the cover slip with clear nail polish.

The staining procedure gave specimens an overall reddish colouration. In Cladocera, the eye, ocellus, and digestive tract appeared black.

The principle disadvantage of the permanent mount procedure was that it didn't allow for manipulation of the specimen once the animal had been stained and mounted. Where manipulation was desireable, a fresh mount staining procedure was used. There is also some reason to believe that this type of permanent mount preparation crystallizes after five or more years of storage (Dickman, pers. commun.).

A red felt pen having a water soluble dye was used to colour a drop of water on a precleaned slide. The specimen was placed into this medium and left for approximately five minutes. A cover slip was next added and the specimen examined. With this procedure the animal could be easily moved into any desired position. Colour contrast of the specimen was controlled by either applying the felt pen to the water a second time (increasing colour) or, by adding small amounts of water (decreasing colour).

The principle disadvantage of this method was that the stain was not retained by the specimen and therefore permanent storage of stained specimens was not possible. However, once the specimen was identified using the fresh mount staining procedure, a permanent reference mount could be made showing the desired features using the polyvinyl lactophenol turtox-CMC-S staining procedure.

Permanent mount specimens have been deposited with the National Museum of Natural Sciences, Canadian Oceanographic Identification Center, reference number 35F.

For identifications, essentially all names of Cladocera followed Brooks (1959). This reference alone was not completely satisfactory and modifications were deemed necessary.

Brooks (1959) maintained that there were two species of *Bosmina* in North America. Goulden and Frey (1963) supported the idea of creating subgenera. Deevey and Deevey (1971) introduced the European genus, *Eubosimina*, into the fauna of North America. Patalas (1972) retained the old genus of Brooks(1959). I have treated all *Bosmina* specimens as per Brooks (1959) since most researchers are familiar with this nomenclature.

All *Diaphanosoma* specimens were collectively referred to as *Diaphanosoma spp.*

Smirnov and Davis, 1973 have recently indicated that the genera *Scapholeberis* and *Simocephalus* are in need of revision. However, because all of my specimens of these two genera fit the descriptions in Brooks (1959), Brooks' nomenclature has been retained.

Throughout the analysis of the samples two genera were especially troublesome. All *Ceriodaphnia* specimens appeared to best follow the Brooks (1959) description for *C. reticulata*. Based on extreme size variations it appeared that more than one species of *Ceriodaphnia* was represented. For this reason all *Ceriodaphnia* have been recorded as *Ceriodaphnia spp.*

Chydorus specimens were the second troublesome group. I have referred to all *Chydorus* specimens as *Chydorus spp.* A list of *Chydorus* species tentatively identified from my Ottawa River samples is presented in Table 1. Attempts have been made to seek confirmation from specialists but, to date nothing has materialized from these efforts.

Table 1

Tentative list of *Chydorus* species collected in plankton samples from the Ottawa River. (Identifications have not been confirmed.)

Chydorus sphaericus
Chydorus piger
Chydorus latus
* *Chydorus globosus*

* referred to as *Pseudochydorus globosus* by Brandlova *et al.* (1972)

Several species listed by Brooks (1959) have been recently renamed. *Alonella acutirostris* (Birge) 1879 as listed in Brooks (1959) has been reallocated to the genus *Disparalona* (Fryer, 1971) and is now named *D. acutirostris* (Birge) 1879. *Leydigia quadrangularis* (Leydig) 1860 as per Brooks (1959) has been renamed *L. leydigii* (Schoedler) 1863 by Brandlova *et.al.* (1972).

Other than the changes presented above all identifications are based on the descriptions and keys of Brooks (1959). Individual specimens were examined under a light microscope (100X to 400X magnification) for identification purposes.

5. DETERMINATION OF POPULATION DIFFERENCE

In order to get some measure of population differences between habitats, the sampling program included days when two different habitats were sampled the same day. In measuring differences, animal patchiness, a common phenomenon (Wiebe and Holland, 1968; Cushing, 1962; Cassie, 1957) causes a very high variance and must be considered.

Through replicate sampling it is possible to reduce the standard error of the mean. Often replicate sampling is not practical because of the time required to analyze the samples. Non-parametric analyses, although less powerful tests, do allow for the comparison of samples when replicate numbers are reduced. So as to compare populations from different habitats, I chose to use the non-parametric Mann-Whitney U test.

HABITAT CHARACTERIZATION

The sampling program was designed to allow comparison of samples taken from different habitats. These included:

1. a backwater bay (Kettle Island Bay)
2. an open bay (Lower Duck Island Bay)
3. a temporary embayment (Upper Duck Island Bay)
4. the main channel basin.

Each habitat can be distinguished from the others on the basis of its environmental parameters.

1. BACKWATER BAY

The bay is located on the south side of Kettle Island, is approximately 0.8 kilometers in length and has a maximum width of 0.2 kilometers. Depth soundings showed the bay to be a shallow basin with a maximum depth of six meters (Figure 3). The bottom of the bay was covered with a layer of decaying plant material and organic 'ooze'. Towards the mouth of the bay (station 6), the sand particle concentration increased so that in the bay mouth proper, sand was the major constituent of the substrate (approximately 70%).

Aquatic vegetation was restricted to the shallower waters of the bay. This restriction held for both emergent and submersed vegetation. During the peak growing season a dense growth of both types of vegetation developed in the mouth of the bay (Figure 3b).

Figure 3

1. Kettle Island Bay morphometry with depth intervals of one meter. (Data collected September 1972)

2. Distribution of emergent and submersed aquatic vegetation in the Kettle Island Bay. (Data collected 3 August 1972)

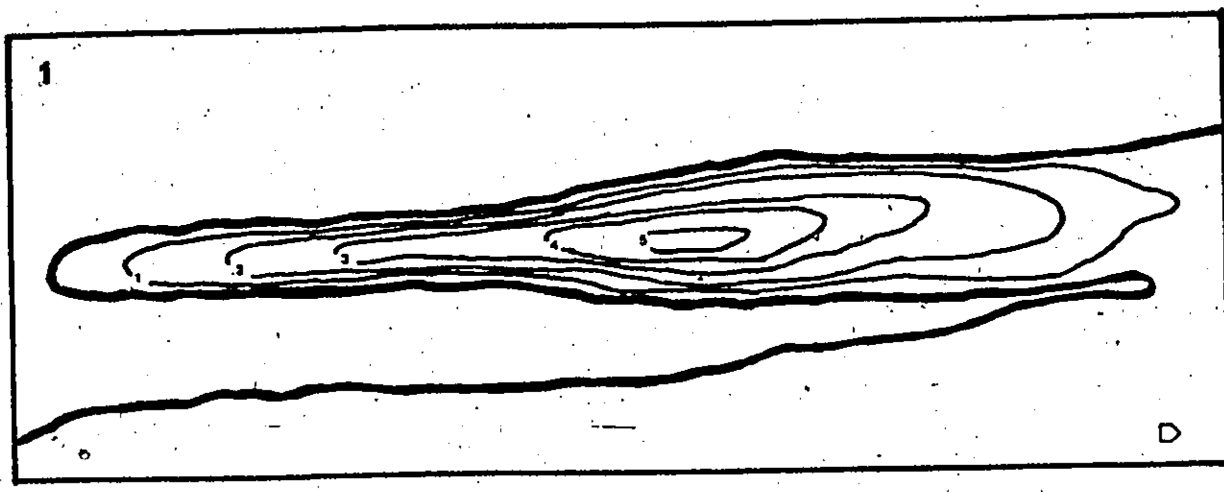
Legend

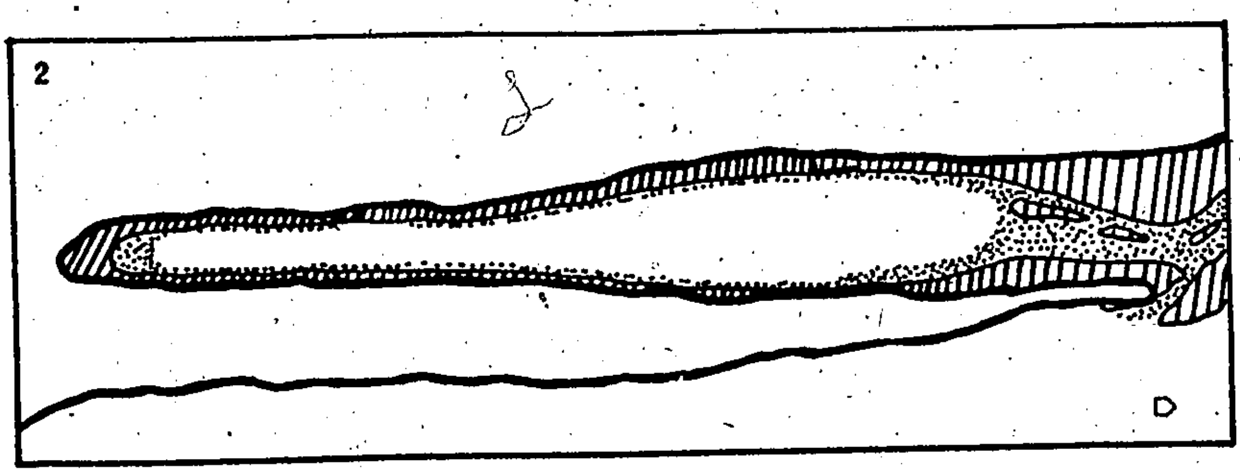
Emergent aquatic vegetation

Submersed aquatic vegetation

Direction of flow

Kettle Island Bay





On-shore vegetation consisting of trees, shrubs, and ground cover formed an effective wind screen. However, winds running the length of the bay were observed to cause some movement of surface waters.

Temperature profiles for the bay showed that thermal stratification occurred in the bay through the summer season (Figure 4). Surface temperatures in the bay were consistently higher than at any other site. Whereas surface conductivity values were similar for all sites, values from the deeper bay waters were higher than any other area and, as with temperature, vertical stratification occurred (Figure 5). Secchi disc readings varied between 0.75 and 1.25 meters from June to October.

In summary, the Kettle Island backwater bay was a sheltered, thermally stratified bay having many characteristics similar to organically enriched shallow lakes.

2. OPEN BAY

As a type habitat, the Lower Duck Island Bay is a geographically defined basin exposed to the wind, influenced by Spring flooding, and subject to periodic, but regular "flushings" by wind driven river water.

The bay is located on the north side of Lower Duck Island where it forms an L-shaped basin. The innermost basin reached a maximum depth of 2.2 meters in the center. The outer basin reached a maximum depth of three meters, with mid basin depths ranging between 2.0 and 2.5 meters.

Figure 4

Water temperatures (°C) for selected Ottawa River stations.

LEGEND

——— June
—·— July
······· August
— — September
- - - October

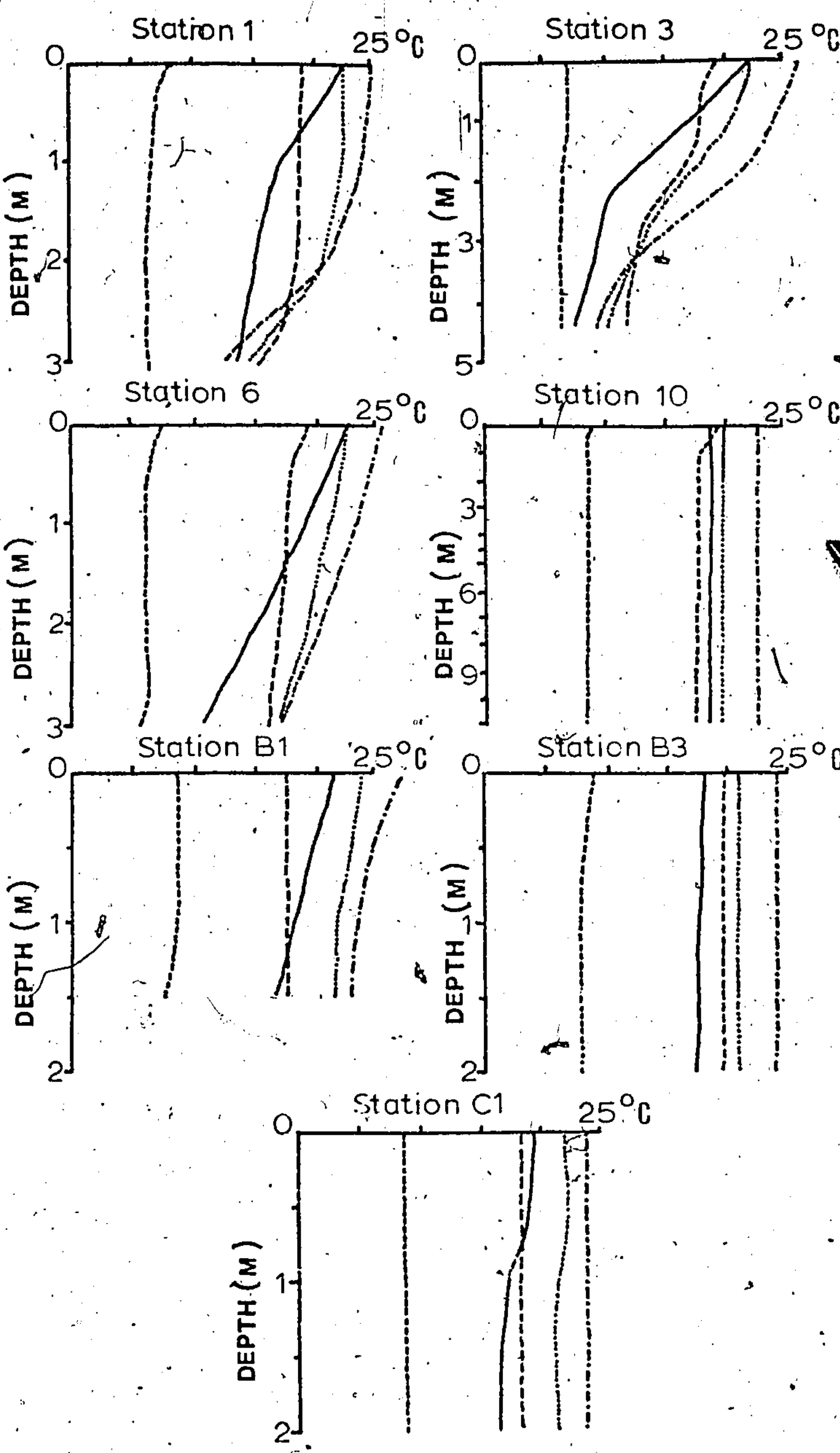

Station 1
25 °C
0
1
2
3
DEPTH (M)
Station 3
25 °C
0
1
3
5
DEPTH (M)
Station 6
25 °C
0
1
2
3
DEPTH (M)
Station 10
25 °C
0
3
6
9
DEPTH (M)
Station B1
25 °C
0
1
2
DEPTH (M)
Station B3
25 °C
0
1
2
DEPTH (M)
Station C1
25 °C
0
1
2
DEPTH (M)

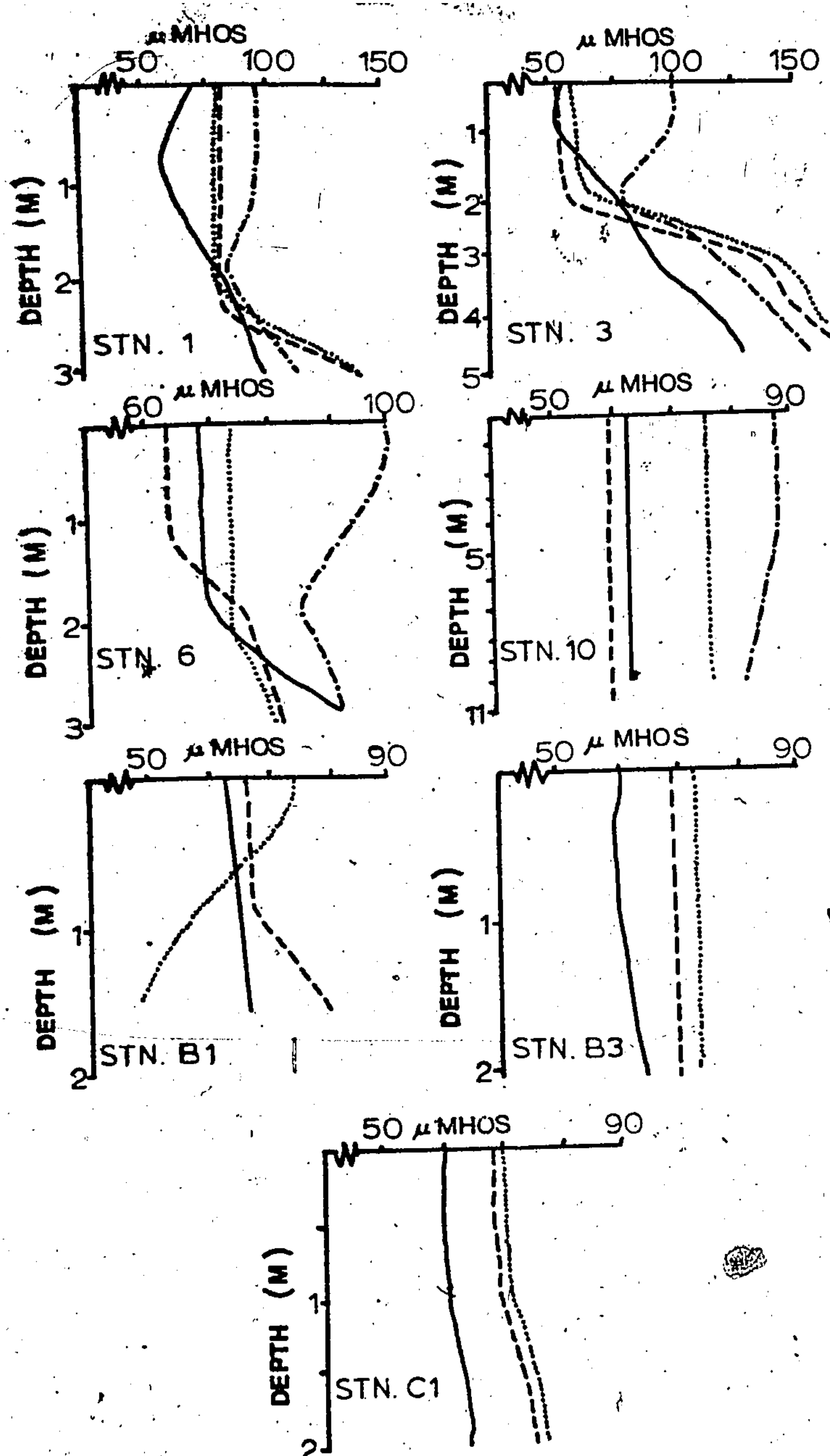
Figure 5

Conductivity measurements (μmhos) for selected Ottawa River stations.

LEGEND

—— June
—·— July
······ August
—·—— September
---- October

NB - no conductivity values available for July at stations B1, B3, C1.


µ MHOS
50
100
150
DEPTH (M)
1
2
3
STN. 1
µ MHOS
50
100
150
DEPTH (M)
1
2
3
4
5
STN. 3
µ MHOS
60
100
DEPTH (M)
1
2
3
STN. 6
µ MHOS
50
90
DEPTH (M)
5
11
STN. 10
µ MHOS
50
90
DEPTH (M)
1
2
STN. B1
µ MHOS
50
90
DEPTH (M)
1
2
STN. B3
50 µ MHOS
90
DEPTH (M)
1
2
STN. C1

The two basins were joined by a channel where depths reached only 1.2 meters (Figure 6).

Observations of bottom samples showed that there were slight differences between the two basins. Although both were high in wood chip content (20%), the inner basin basin included approximately 30 per cent more decaying organic material.

Through most of the summer, aquatic vegetation was dense in this area. Emergent vegetation was concentrated from the shore inwards. The distribution of the submersed vegetation followed a somewhat patchy pattern through the central portions of the bay. Although the aquatic vegetation was dense through the summer growing season, the substrate showed limited evidence of decomposing plant material (Figure 6).

Unlike the Kettle Island Bay area, the onshore vegetation was all low growing plant material providing minimal protection from wind. The terrestrial vegetation was typical of wetlands - sedges, grasses, and alders. The south side of the bay was protected from wind by a hedge of small trees some ten to fifteen meters from the water's edge.

During the summer growing season a slight thermal depth gradient was observed for the innermost bay. Surface water temperatures were highest in the innermost basin from June to August. By mid September, surface water temp-

Figure 6

1. Lower Duck Island Bay morphometry with depth intervals of one meter. (Data collected September 1972)

2. Distribution of emergent and submersed aquatic vegetation in the Lower Duck Island Bay. (Data collected 11 August 1972)

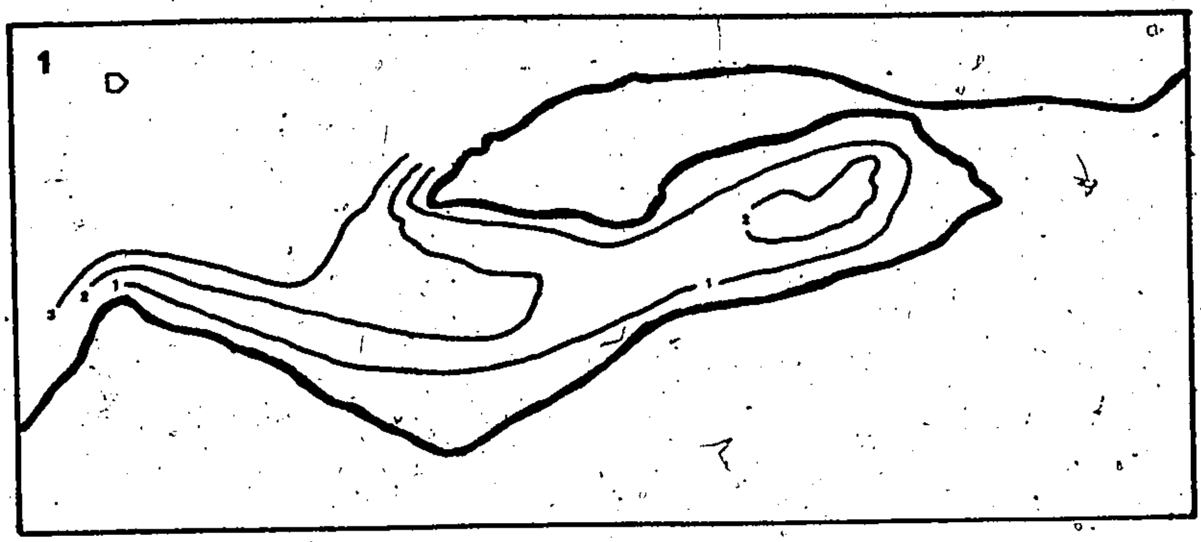
Legend

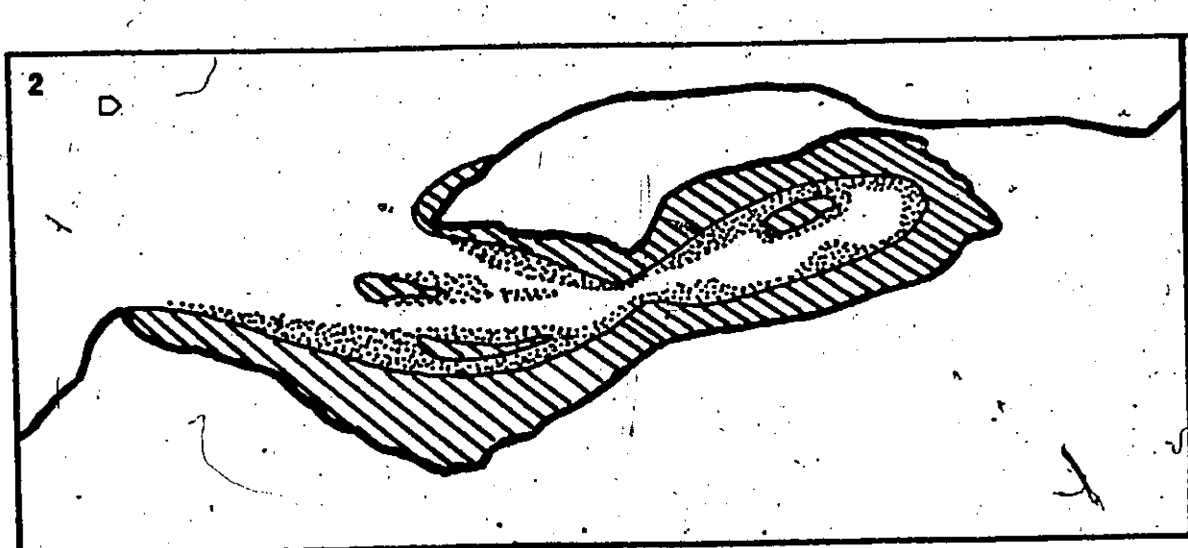
▨ Emergent aquatic vegetation

⬚ Submersed aquatic vegetation

▷ Direction of flow

Lower Duck Island Bay





eratures were the same for both basins and the main channel.

The fiber content of the water in this area was equivalent to that of the Kettle Island Bay accounting for less than five percent of the total suspended material. Due to restricted depth, the presence of aquatic vegetation, and the easily stirred-up nature of the substrate, secchi disc readings were not reliable for this area. In examining the samples and comparing them with those from Kettle Island, the algal cell concentrations appeared to be greatly reduced.

3. TEMPORARY EMBAYMENT

Unlike the two previous habitats, the Upper Duck Island area was characterized by the absence of a defined basin. Due to the nature of its boundaries, the bay existed only during the summer and even then, some variation occurred in the delineation of its boundaries.

During the summer, a hedge of emergent and submersed aquatic vegetation developed perpendicular to the island at its western tip (Figure 2 Insert C). Coinciding with this macrophytic hedge was a sand ridge. Examination of the bottom of the embayment showed that sand comprised approximately 90 percent, by volume, of the substrate.

The emergent vegetation was restricted to areas not exceeding one meter in depth. These included the shallower areas of the shore and sand ridge. The central portion of the bay was two meters in depth (maximum) and the bottom was covered with rooted submersed vegetation. The aquatic vegetation of the central portion of this Bay was less dense than that of the Lower Duck Island area, but more uniform in distribution.

Like the Lower Duck Island area, the Upper Duck Island Bay habitat was exposed to winds from all directions. There was some protection from south winds due to terrestrial plant growth, but this was minimal as onshore vegetation was low and set well back from the water's edge. Observations of floating objects showed that river current did exist in the Bay but was greatly reduced compared to that of the main channel (5:1).

Temperature data showed that a very slight thermal gradient existed within the Bay. This was apparent only when the macrophytes reached their maximum density. By mid September, the macrophytes had begun to disappear and the Bay waters did not differ noticeably from those of the main channel in terms of temperature.

Conductivity values were comparable between Upper Duck Island and the main channel.

As a habitat type, the Upper Duck Island area was a temporary embayment which developed during the summer growing season but never completely eliminated water throughflow.

4. MAIN CHANNEL BASIN

The greatest volume of water in the study area was contained within the river's main channel basin as expected. This habitat was characterized by the presence of a strong persistent current, the absence of any thermal gradient in the water column, and the restricted growth of aquatic vegetation.

As shown in Figures 4 and 5, neither a temperature nor a conductivity vertical depth gradient existed within the main channel at the sites examined. This would suggest that a complete mixing of waters occurred throughout the summer season.

Aquatic vegetation was found within the main basin but was restricted to a narrow band adjacent to the shores termed the littoral zone. All samples in the main channel were taken near the center of the channel well away from the littoral zone.

The fiber content in water taken from the main channel was higher than at any of the other stations (approximately 60 percent of the seston biomass). Secchi disc readings were consistent throughout the sampling period at 1.75 meters. A small amount of sand appeared to be transported by the river, within the main channel, a condition not noticed elsewhere.

The bottom was variable but primarily composed of sand and clay. Decomposing organic material was almost completely absent from the river bottom.

Generally speaking, the main channel basin habitat was characterized by the completely mixed nature of the water, the presence of a strong, persistent current, and the presence of a high fiber content.

RESULTS

1 INVERTEBRATE COMPOSITION OF SAMPLES

A total of nine phyla were represented within the samples (eight of which were invertebrate phyla). As the sampling methods were non-quantitative for Rotifera, no attempt was made at estimating their abundance within the samples. Of the seven remaining invertebrate phyla, Arthropoda were the most abundant (Table 2).

1.1 ARTHROPODA

A total of 14 arthropod orders were collected (Table 3), six orders of Crustacea and eight insect orders.

With the exception of <u>Chaoborous</u> species (Diptera) collected from the deepwater central stations of the Kettle Island Bay, insects were taken in low numbers. <u>Chaoborous</u> densities reached peak levels during mid to late July with recorded densities exceeding 330 individuals per cubic meter on several different occassions. The insect orders and their rank of abundance by habitat are listed in Table 3.

Of the five crustacean orders present, Cladocera were the most abundant. Copepods were the second most abundant order, with Cyclopoida always more abundant than Calanoida. Amphipoda and Isopoda were the least abundant orders of Arthropoda.

Table 2

Rank order of abundance for the Invertebrate phyla collected from the Ottawa River using plankton nets.

	HABITAT			
PHYLUM	Kettle Is.	Lower Duck Is.	Upper Duck Is.	Main Channel
Arthropoda	1	1	1	1
Annelida	3	2	2	3
Nematoda	2	3	3	2
Coelenterata	4.5	4	4.5	4.5
Mollusca	4.5	5	4.5	4.5
Tardigarda	abs*	6	abs	abs
Bryozoa	6	abs	abs	6
Rotifera	nq**	nq	nq	nq
Total phyla present per habitat	7	7	6	7

*abs - not recorded for habitat
**nq - data not quantitative

Table 3

Rank order of abundance for Arthropoda orders collected from the Ottawa River using plankton nets.

ORDER	Kettle Is.	Lower Duck	Upper Duck	Main Channel	All**
Crustacea					
Cladocera	1	1	1	1	1
Copepoda	2	2	2	2	2
Ostracoda	3	3	3.5	4	3
Harpacticoida	5	4	5	5	4
Amphipoda	6.5	8.5	6.5	6	6
Isopoda	6.5	8.5	6.5	7.5	8
Insecta					
Diptera	4	5	3.5	3	5
Ephemeroptera	abs*	10	8	abs	9.5
Odonata	abs	12	10.5	abs	12
Coleoptera	8	12	abs	abs	12
Plecoptera	abs	7	10.5	7.5	9.5
Lepidoptera	abs	12	10.5	abs	12
Trichoptera	abs	6	10.5	abs	7
Hymenoptera	9	abs	abs	abs	14
Total number of orders present	9	13	12	8	14

*abs - not recorded for habitat

**All - Mean for all habitats in study area.

Calanoida genera present in the plankton samples included _Diaptomus_, _Eurytemora_, and _Epischura_. Of these _Diaptomus_ was the most abundant. Cyclopoida genera present included _Cyclops_, _Tropocyclops_, and _Mesocyclops_. The Copepoda species list (Table 4) is probably not complete as the emphasis of the study was on Cladocera. The seasonal comparison of copepods and cladocerans is shown in Figure 7.

Table 4

Copepoda species collected in plankton samples from the Ottawa River.

CALANOIDA

Diaptomus oregonensis Lilljeborg 1889
Diaptomus minutus Lilljeborg 1889
Diaptomus sicilis S.A.Forbes 1882
Diaptomus leptopus S.A.Forbers 1882
Eurytemora affinis (Poppe) 1880
Epischura lacustris S.A.Forbes 1882

CYCLOPOIDA

Cyclops vernalis Fischer 1853
Cyclops bicuspidatus thomasi S.A.Forbes 1882
Mesocyclops edax (S.A.Forbes) 1891
Tropocyclops parsinus mexicanus Kiefer 1938

1.2 ANNELIDA

All three classes of Annelida were represented within the samples. Oligochaeta were common whereas the other two classes were present in only trace numbers.

1.2.1 OLIGOCHAETA

Oligochaetes were observed to reach greatest densities

Figure 7

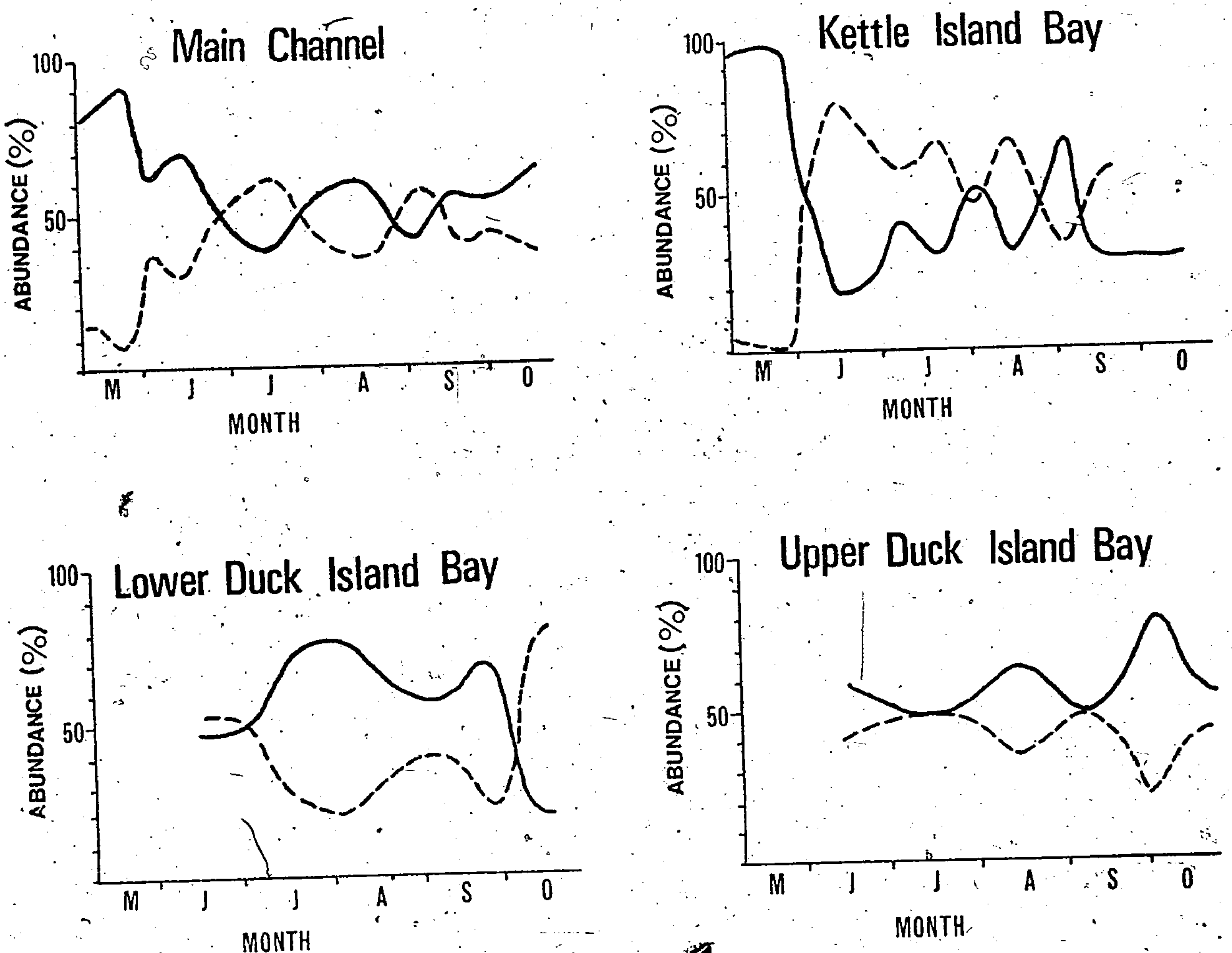
The seasonal abundance of Cladocera and Copepoda for the various habitats sampled in the Ottawa River. (Data expressed in percentages)

LEGEND

——— Copepoda*

– – – Cladocera

* Copepoda includes both mature and immature Calanoida and Cyclopoida


Main Channel
100
50
ABUNDANCE (%)
M J J A S O
MONTH
Kettle Island Bay
100
50
ABUNDANCE (%)
M J J A S O
MONTH
Lower Duck Island Bay
100
50
ABUNDANCE (%)
M J J A S O
MONTH
Upper Duck Island Bay
100
50
ABUNDANCE (%)
M J J A S O
MONTH

in association with aquatic vegetation. Those areas low in the degree of development of aquatic vegetation were correspondingly low in oligochaetes. With the Fall reduction in aquatic vegetation, the frequency of oligochaete appearance in the main channel sites appeared to undergo a slight increase. These two observations suggested that the species of Oligochaeta collected were most probably species which lived in close contact with aquatic vegetation. The apparent increase in mid river oligochaete frequency was thought to be related to the reduction of available suitable substrate.

The principle oligochaetes collected were Stylaria and Chaetogaster. Other oligochaetes were present in minimal numbers but were not identified.

1.2.2 POLYCHAETA

Polychaetes were represented within the samples by a single species, Manayunkia speciosa Leidy 1858. Although present in only a few samples (4), it was collected from four different sites within the study area. These sites included the main channel (station 10), the Rockcliffe Dock area (station 11), the south shore of Kettle Island (station 9), and the Lower Duck Island Bay. In all cases, except for the mid river channel site, the polychaete was most probably taken from the substrate in the vertical tow. In the main channel site the fact that contact was not made with the substrate, suggests that the organism was being passively dispersed downstream by the current.

The distribution of M. speciosa has been reviewed by Mackie and Qadri (1971). These authors have also commented on its Ottawa River distribution.

1.2.3 HIRUDINEA

Only a single leech specimen in one sample was collected and that from the Lower Duck Island Bay on July 8, 1972.

1.3 NEMATODA

Nematodes were collected from all habitat types. They were present in both open water and shallow water samples. Although numbers were never comparable to those for Crustacea, some seasonal abundance patterns did appear to occur. Nematoda numbers appeared to be highest towards late June and through the summer growing season, decreasing in mid September.

Except for the lower numbers collected at the Kettle Island Bay sites, all habitats appeared to be comparable in nematode numbers with a mean density of 90 individuals per cubic meter sampled being common.

1.4 COELENTERATA

The principle coelenterata species found has been tentatively identified as Hydra littoralis Hyman 1931. Highest concentrations appeared in the inner sections of the Lower Duck Island Bay (stations B1 and B2) where it was found throughout the summer growing season. As the aquatic vegetation died down, the concentration of *H. littoralis* decreased. Highest numbers occurred in horizontal hauls where it was found to be consistently represented through late June, July, and August. Vertical haul samples taken the same day in the same areas often failed to collect specimens.

Occasional specimens of *H. littoralis* were collected at the mid river stations and in the Bay mouth area of Kettle Island. Concentrations in these areas were always low and rarely exceeded five individuals per cubic meter. Specimens from mid river stations were never found in association with any form of substrate.

1.5 MOLLUSCA

Other than the occasional *Amnicola*, Mollusca specimens were of the family Sphaeriidae. The Lower Duck Island Bay area and the mouth of the Kettle Island Bay were the most common sites for Sphaeriidae. Molluscs were not consistently collected at any station in the sampling area using plankton nets.

1.6 TARDIGRADA

All Tardigrada collected came from the Lower Duck Island Bay site, station B1, and were collected on a single sampling day, September 28, 1972. Because of their small size and colouration when preserved in five percent formaldehyde, it is possible that they could have been overlooked in some of the samples. It is improbable that had they occurred in high densities, they would have been overlooked.

All specimens have been tentatively identified as members of the genus <u>Macrobiotus</u>.

1.7 BRYOZOA

Only a single small bryozoan was found within the samples. It was collected from the Kettle Island Bay mouth area on July 22, 1972. Larger colonial type bryozoans were observed in the shallow waters of the Kettle Island Bay on several different sampling days throughout the summer.

2. HABITAT TAXA REPRESENTATION

Monthly data on the number of taxa collected per habitat is presented in Table 5.

Generally speaking, those habitats which exhibited the greatest growth of aquatic vegetation also recorded the greatest number of invertebrate taxa (Kettle Island Bay mouth and Lower Duck Island Bay). An area with no aquatic vegetation, such as the central stations of Kettle Island Bay, was the lowest in terms of total number of taxa present. It is thought that recruitment from other habitats was responsible for the mid channel sites being higher than the Kettle Island Bay area in terms of total taxa present.

Table 5

Mean numbers of invertebrate taxa recorded per habitat in Ottawa River samples from May - October 1972

MONTH	KETTLE ISLAND	BAY MOUTH	UPPER DUCK	LOWER DUCK	MID RIVER	STATIONS 9 & 11
May	5.4(10)	5.5(4)	-	-	5.0(2)	4.7(3)
June	4.9(26)	6.6(5)	8.7(4)	6.6(10)	6.0(3)	7.6(5)
July	5.1(15)	7.4(13)	6.7(3)	8.1(16)	5.9(7)	5.4(5)
August	4.6(7)	7.2(11)	6.5(10)	6.5(18)	5.9(9)	
September	4.6(13)	6.3(4)	7.0(4)	7.8(17)	5.3(7)	7.0(3)
October	5.2(13)	6.2(5)	5.4(5)	6.2(11)	4.0(4)	5.7(3)
MEAN ($\overline{X}$)	4.97	6.83	6.73	7.13	5.48	6.17

NB: number in brackets indicates number of samples used to calculate monthly mean

Temporally speaking, the Kettle Island Bay site was the most consistent in terms of the number of taxa present throughout the sampling period. The shallow water stations in the main channel basin (Upper Duck Island and stations 9 and 11) showed the greatest degree of variability throughout time.

3. CLADOCERA

The species of Cladocera collected are listed in Table 6. A total of 45 species in 27 genera were collected. By combining data collected from the Ottawa River with results reported in the literature, it is possible to obtain information on the apparent habitat preferences of specific cladoceran species.

3.1.1 Bosmina longirostris

Bosmina longirostris was the only cladoceran to be found in high density in all of the Ottawa River habitats. No other species was taken in comparable numbers nor in as many samples. It reached peak values in the Kettle Island Bay (166,100 individuals per cubic meter) during mid June (12 June, 1972; mean value of 10 replicates). Generally its lowest densities were found in mid river samples and shallower areas of dense aquatic vegetation. B. longirostris abundance in each habitat type sampled for the Ottawa River is depicted in Figure 8.

Table 6

Taxonomic list of species of Cladocera collected from the Ottawa River during the sampling period, 13 May 1972 - 28 October 1972 (Family & species)

Leptodoridae

Leptodora Kindtii (Focke 1844)

Polyphemidae

Polyphemus pediculus (Linne 1761)

Holopedidae

Holopedium gibberum Zaddach 1855

Sididae

Sida crystallina (O.F.Muller 1785)
Latona setifera (O.F.Muller 1785)
Latona parviremis Baird 1910
Diaphanosoma spp. Fischer 1850
Latonopsis occidentalis Birge 1891

Daphnidae

Daphnia ambigua Scourfield 1947
Daphnia dubia Herrick 1895
Daphnia galeata mendotae Birge 1918
Daphnia parvula Fordyce 1901
Daphnia retrocurva Forbes 1882
Daphnia pulex Leydig 1860
emend Richard 1896
Daphnia longiremis Sars 1861
Simocephalus vetulus Schodler 1858
Simocephalus serrulatus (Kock 1841)
Scapholeberis kingii Sars 1903
Ceriodaphnia sp. Dana 1853

Bosminidae

Bosmina longirostris (O.F.Muller 1785)

Chydoroidae

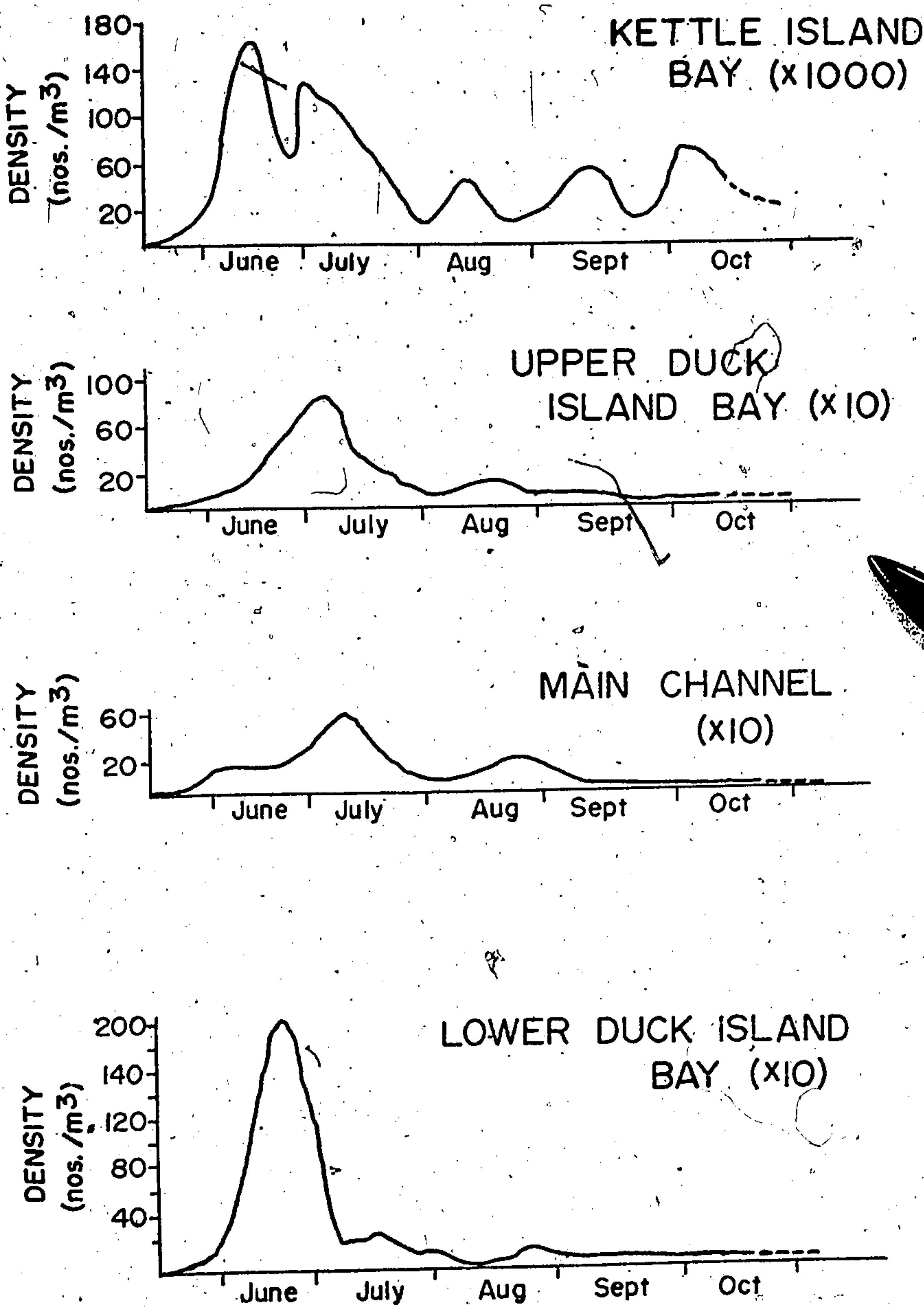
Eurycercus lamellatus (O.F.Muller 1785)
Camptocercus rectirostris Schodler 1862
Acroperus harpae Baird 1843
Kurzia latissima (Kurz 1874)
Graptoleberis testudinaria (Fischer 1848)
Leydigia leydigii (Schoedler 1863)
Alona affinis (Leydig 1860)
Alona costata Sars 1862
Alona guttata Sars 1862
Alona rectangula Sars 1861
Alona quadrangularis (O.F.Muller 1785)
Pleuroxus procurvus Birge 1878
Pleuroxus hastatus Sars 1862
Pleuroxus trigonellus (O.F.Muller 1785)
Pleuroxus denticulatus Birge 1878
Pleuroxus uncinatus Baird 1850
Pleuroxus hamulatus Birge 1910
Alonella excisa (Fischer 1854)
Disparalona acutirostris (Birge 1879)
Monospilus dispar Sars 1861
Chydorus spp. Leach 1843

Macrothricidae

Streblocercus serricaudatus (Fischer 184
Ilyocryptus spinifer Herrick 1884
Ophryoxus gracilis Sars 1861

Figure 8

Abundance of Bosmina longirostris for the various habitats sampled in the Ottawa River.



KETTLE ISLAND BAY (x1000)
DENSITY (nos./m3)
180
140
100
60
20
June
July
Aug
Sept
Oct
UPPER DUCK ISLAND BAY (x10)
DENSITY (nos./m3)
100
60
20
June
July
Aug
Sept
Oct
MAIN CHANNEL (x10)
DENSITY (nos./m3)
60
20
June
July
Aug
Sept
Oct
LOWER DUCK ISLAND BAY (x10)
DENSITY (nos./m3)
200
140
120
80
40
June
July
Aug
Sept
Oct

During the summer months the Kettle Island Bay exhibited thermal stratification with temperatures recorded for the deeper waters being colder than elsewhere within the study area. B. longirostris densities recorded would appear to agree with the findings of Bhajan and Hynes (1972) who found Bosmina spp. in Sunfish Lake (Ontario) to be located in areas where the water was cool and well oxygenated. Within my Ottawa River habitats, oxygen does not appear to be a critical facotr.

Hall et al. (1970) found in their experimental ponds that Bosmina occurred exclusively in ponds having planktivorous fish populations. Other Ottawa River researchers have suggested that the Kettle Island Bay supports one of the densest fish populations in the study area (Rubec, pers. commun.).

3.1.2 Daphnia spp.

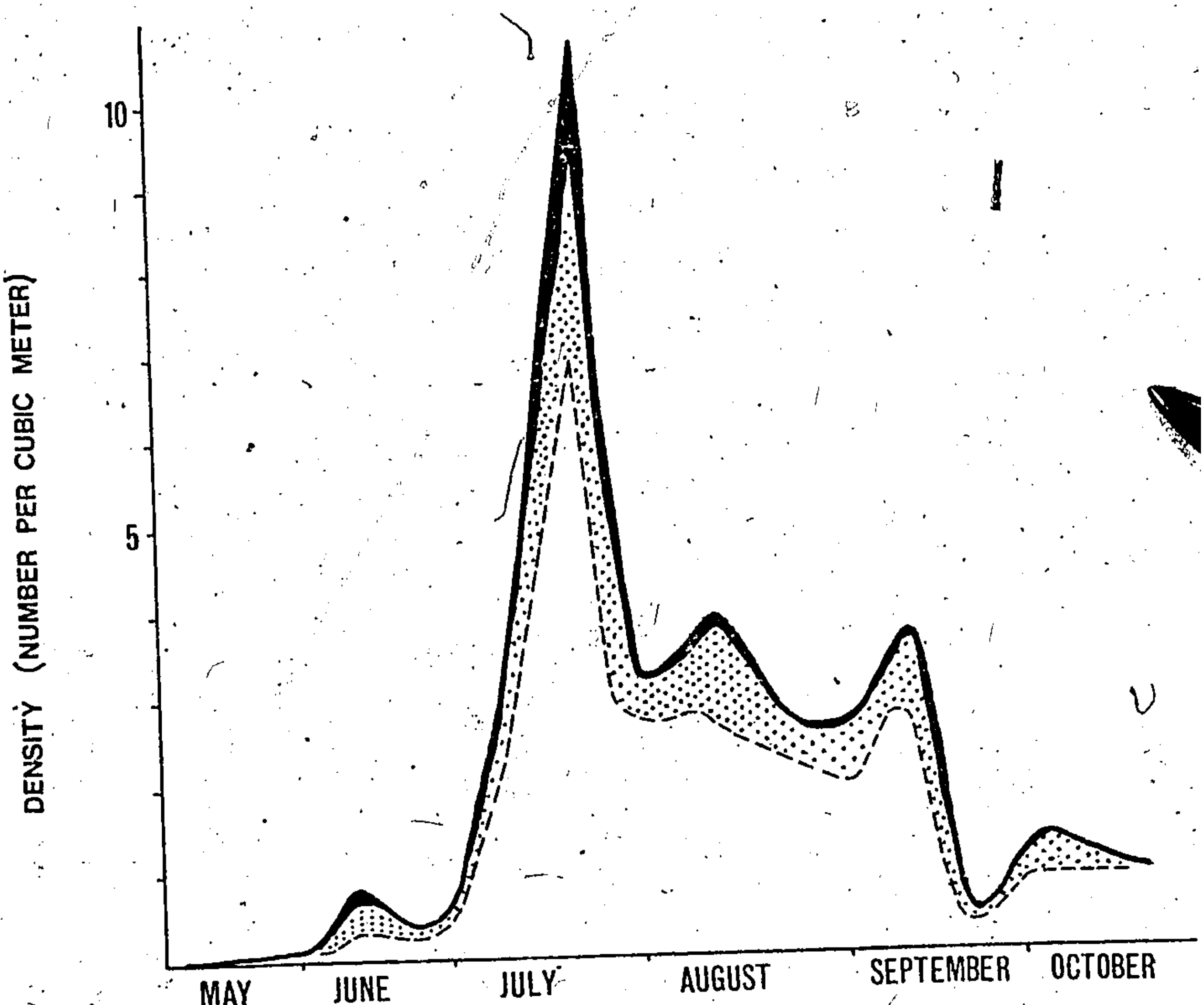
Although Daphnia species were collected from all habitats, it was only at the Kettle Island Bay sites that they were collected consistently and in relatively high densities. The temporal density of Daphnia for the Kettle Island Bay area is shown in Figure 9. All other habitats were so inconsistent in Daphnia representation that they could not be similarly plotted. The bay mouth area of Kettle Island ranked second in terms of density of Daphnia representation in the plankton samples.

Figure 9

Temporal abundance of *Daphnia parvula*, *D. ambigua*, and *D. retrocurva* in the Kettle Island Bay habitat.

Legend

- □ *D. parvula*
- ▒ *D. ambigua*
- ■ *D. retrocurva*


10
5
DENSITY (NUMBER PER CUBIC METER)
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

A total of seven species of _Daphnia_ were collected and of these, only three occurred with any consistency (Table 7). According to Brooks (1957) the three more commonly occurring _Daphnia_ species are all pond-lake dwelling species.

Table 7

Daphnia species from the Ottawa River arranged according to densities observed in plankton samples.

HIGH DENSITY (100+/cu.m.)	LOW DENSITY (100 /cu.m.)
D. ambigua	_D. dubia_
D. parvula	_D. galeata mendotae_
D. retrocurva	_D. longiremis_
	D. pulex

D. retrocurva was the only species collected from all habitats. _D. dubia_ was reported only from the Kettle Island Bay sites. All other _Daphnia_ species were reported from two or more sites.

The most abundant _Daphnia_ species in the Kettle Island Bay area were all small species. Predation upon _Daphnia_, a well documented phenomenon, (Hall _et al._, 1970; Jacobs, 1966; Kerfoot, 1972; Noble, 1971) may be an important factor controlling _Daphnia_ population numbers within the Kettle Island Bay. Hutchinson (1971) reported that _D. ambigua_ was able to avoid predators and that this avoidance success was attributed to its small size. This is consistent with the observation that within the Kettle Island Bay the most abundant _Daphnia_ species were small in size. It is possible that some other factor may be affecting the Daphnia population

3.1.3 Ceriodaphnia spp.

Ceriodaphnia spp. were collected from all habitats, with both the greatest density and frequency of appearance occurring in the Kettle Island Bay.

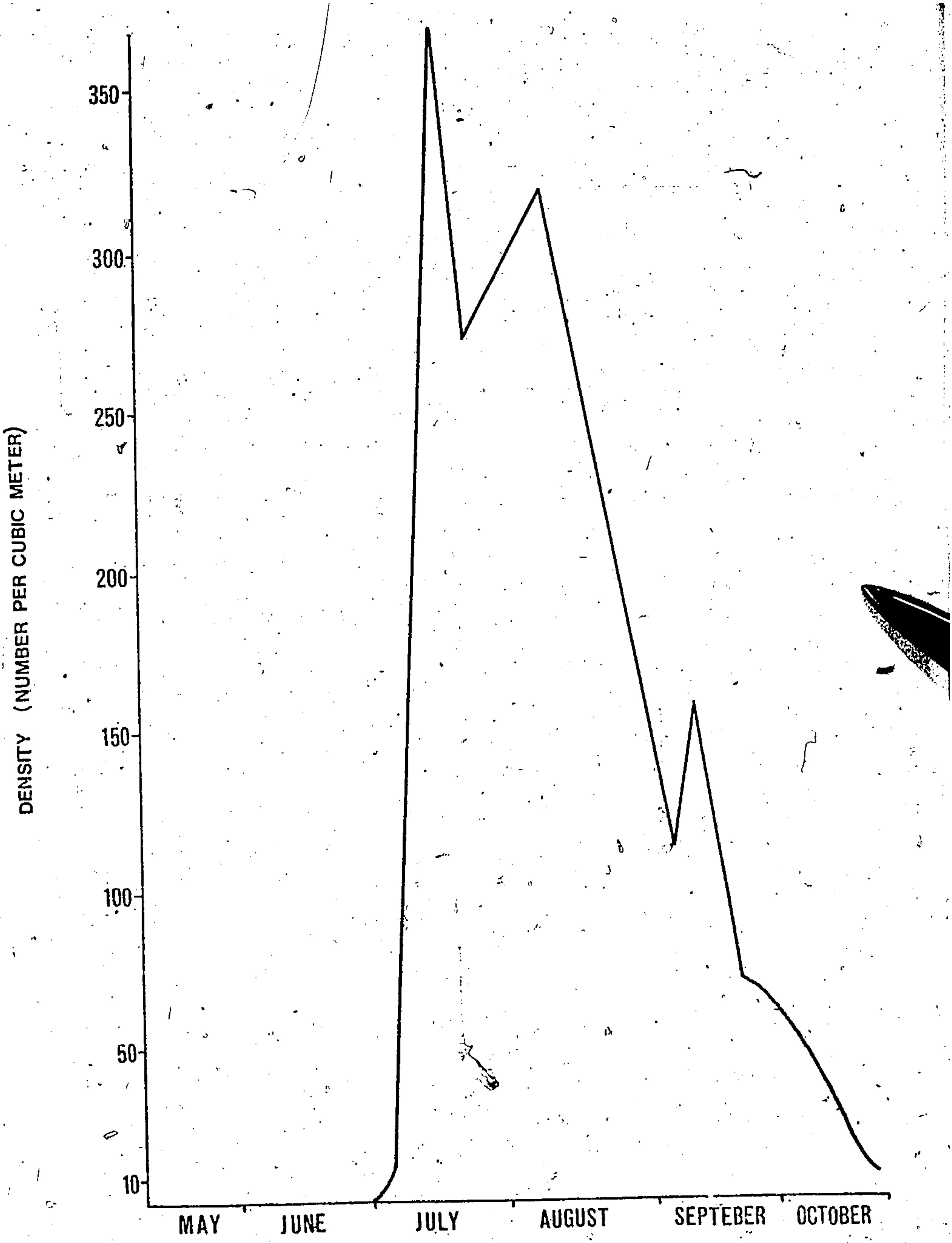
In the Kettle Island Bay, Ceriodaphnia spp. were first collected in mid June and remained in the bay throughout the sampling period (Figure 10). Numbers were comparable to those reported for Daphnia with maximum numbers for both species occurring at the same time (approximately July 20, 1972). Although Ceriodaphnia and Daphnia reached peak densities at approximately the same time, Ceriodaphnia appeared to maintain its peak densities for a longer period of time than did Daphnia.

Of the other habitats containing Ceriodaphnia spp., numbers and frequencies were approximately equal for the bay mouth and Lower Duck Island habitats. Both densities and frequencies for Ceriodaphnia were higher than those reported for Daphnia spp.

As is the case for Daphnia, cyclomorphosis does occur. Zaret (1972) suggested that cyclomorphosis in Ceriodaphnia may be a response to size selective predation. As with Daphnia, only small specimens of Ceriodaphnia were noted within the samples.

Figure 10

Temporal abundance of <u>Ceriodaphnia</u> <u>spp</u>. within the Kettle Island Bay.


DENSITY (NUMBER PER CUBIC METER)
350
300
250
200
150
100
50
10
MAY
JUNE
JULY
AUGUST
SEPTEBER
OCTOBER

3.1.4 Leptodora kindtii

Leptodora kindtii was reported from all habitats except the Upper Duck Island temporary embayment. Only in the Kettle Island Bay and bay mouth areas did the species attain any large density or show any regularity of appearance within the samples. The temporal density of L. kindtii for the Kettle Island Bay is illustrated in Figure 11.

In the Kettle Island Bay, L. kindtii reached peak densities approximately 3.5 weeks (June 7, 1972) after Bosmina longirostris numbers were at a maximum and approximately 1.5 weeks before Daphnia and Ceriodaphnia peaked. L. kindtii was noticed to increase at approximately the same time as the cyclopoid population appeared to reach its maximum density. It appeared that as L. kindtii increased cyclopoid numbers decreased.

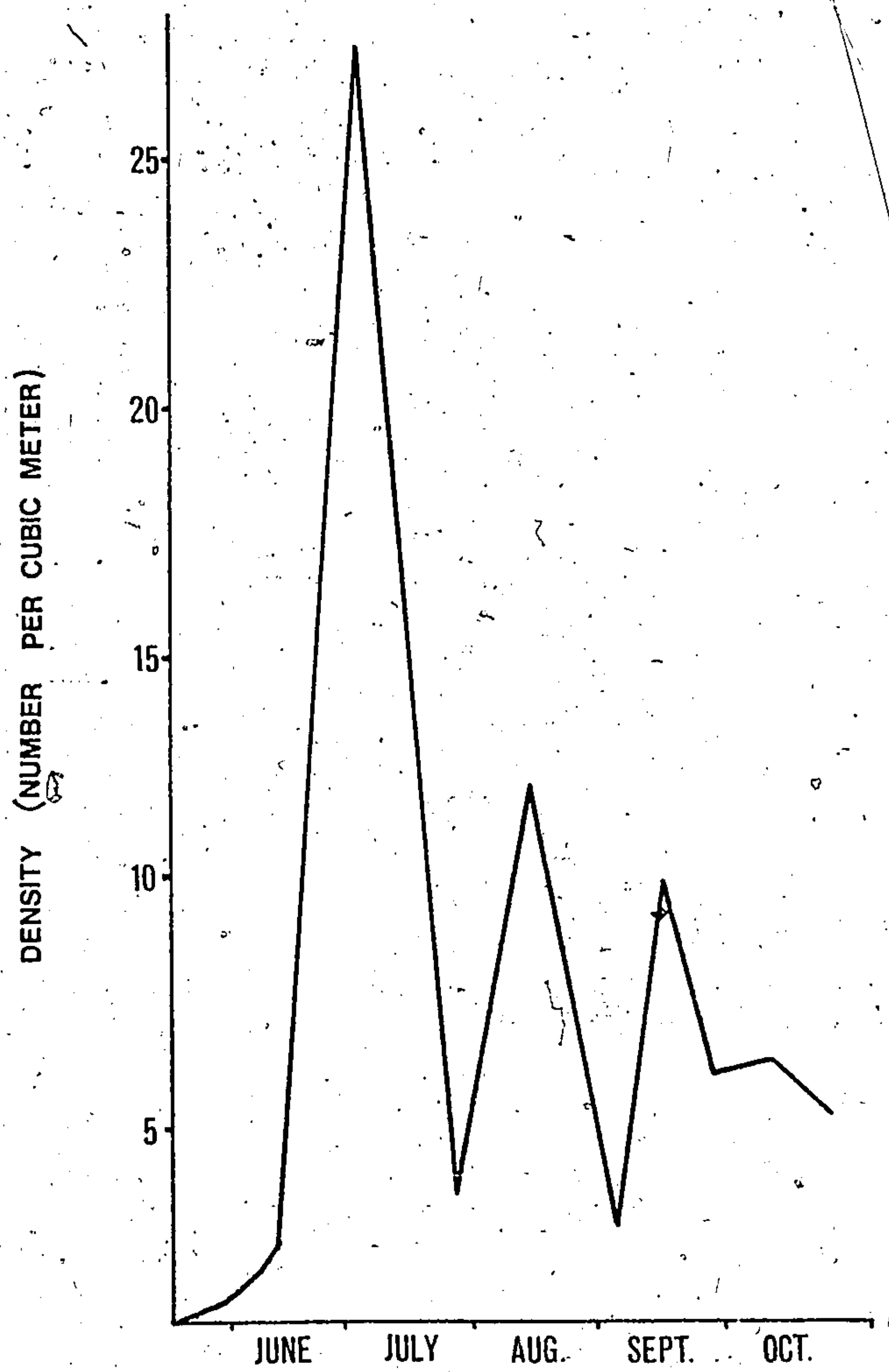
Found in low numbers in both lakes and ponds (Brooks, 1959), L. kindtii is a predaceous cladoceran which appears able to utilize a wide range of prey while maintaining a planktonic existence (Cummins et al., 1969). Within the Ottawa River study area the only habitat exhibiting lake or pond characteristics was the Kettle Island Bay and it was within this same area that the greatest concentration of L. kindtii was found.

3.1.5 Eurycercus lamellatus

Eurycercus lamellatus appeared to be an ubiquitous species, collected at all habitats wihin the Ottawa River

Figure 11

Temporal abundance of Leptodora kindtii in the Kettle Island Bay.


DENSITY (NUMBER PER CUBIC METER)
25
20
15
10
5
JUNE
JULY
AUG.
SEPT.
OCT.

study area. It first appeared in the May and June samples in the Kettle Island Bay area and subsequently was collected in late June and July at the other habitats. When aquatic vegetation developed, it was most often collected among vegetation proximal to open water areas. In open water its density was lower (15 - 30 individuals per cubic meter) than in vegetated areas where values often exceeded 600 individuals per cubic meter.

In the absence of aquatic vegetation, E. lamellatus was collected from habitats having a decomposing organic substrate. Being a detritus feeder (Frey, 1971) this organic material may have been a food source for E. lamellatus.

As shown by Smirnov (1972), numbers of E. lamellatus reach their highest density in aquatic vegetation as was the observation for the Ottawa River. E. lamellatus is capable of surviving in the absence of aquatic vegetation, but usually in lower densities as was observed in the Kettle Island Bay.

Brooks (1959) points out that this species is one of the largest chydorids. In examining the stomach contents of several channel catfish taken from the Ottawa River I found several specimens of E. lamellatus but no other cladoceran. Size selective predation may be another factor reducing numbers, most particularly in the Kettle Island Bay.

3.1.6 Alona spp.

Alona affinis followed the same density distribution pattern as Eurycercus lamellatus within the study area. Alona affinis occurred in 47 samples (13.5 % of the total samples) during the course of the sampling program. Only four of these 47 samples were horizontal hauls. In 17 vertical haul samples it reached densities in excess of 50 individuals per cubic meter. Most of these latter samples were collected from the two Duck Island areas although specimens were taken throughout the sampling season (Table 8). Greatest densities occurred during late June and early September.

Table 8

Number of samples containing Alona affinis, arranged according to habitat and month, for the Ottawa River.

	MONTH					
	May	June	July	Aug.	Sept.	Oct.
Kettle Is.	-	2	-	-	-	-
Lower Duck Is.	-	6	4	4	5	2
Upper Duck Is.	-	3	3	-	-	-
Main Channel	-	1	2	1	-	-
Bay Mouth (Ket. Is.)	-	4	3	-	2	-

Although four other Alona species were collected, none showed the density or frequency of appearance exhibited by A. affinis. Following A. affinis, A. quadrangularis was the most frequent Alona species, appearing in 12 samples. A. guttata, A. rectangula, and A. costata were the least frequent species.

All Alona species followed the same distribution patterns as did A. affinis, appearing frequently during June and July in the Duck Island areas. Congeneric occurrence in better than 30 percent of the samples was noted. _A. affinis_ with _A. quadrangularis_ was the most common association. Occasionally _A. guttata_ was also found in the same association.

Goulden (1964) reported _A. affinis_ most often associated with surface mud and stated that it could be found in the mud of deep temperate lakes when sufficient oxygen was present. Sebestyen (1948) reported _A. affinis_ in low numbers among _Potamogeton_ beds. Within the Ottawa River it was difficult to determine whether _A. affinis_ was associated with the aquatic vegetation or with the substrate.

3.1.7 _Diaphanosoma spp._

Diaphanosoma spp. was another cladoceran found in all habitats of the Ottawa River study area. Slightly higher densities were reported from the Kettle Island Bay area and from the bay mouth area. With the exception of the main channel sites, all other habitats reported approximately equal concentrations of _Diaphanosoma spp._ In each habitat, numbers were somewhat lower in dense aquatic vegetation than immediately adjacent to the plant beds.

Applegate and Mullin (1967) found that the occurrence of _Diaphanosoma_, in terms of time, closely paralleled that of _Ceriodaphnia_ and this appears to be the case also for the Kettle Island Bay. In other areas, _Ceriodaphnia_ populations were not well developed, therefore not allowing for comparison.

Of all species collected, _Diaphanosoma spp._ showed the greatest consistency in density values from habitat to habitat. Whereas Bosmina longirostris, Daphnia retrocurva, Sida crystallina, and Camptocercus rectirostris were also taken from all habitats, the densities reported for each species suggested that they had apparent preferences for specific habitats. No habitat selection was evident for the Diaphanosoma found in this study.

3.1.8 Sida crystallina

Present at all sites, Sida crystallina reached its greatest densities in the bay mouth and Lower Duck Island Bay areas during late July and early August. Both the Kettle Island Bay and the main river channel sites contained only occasional specimens, even though the intermediate bay mouth area exhibited a well established population. S. crystallina was observed to occur in areas low in the presence of other cladoceran species.

S. crystallina is primarily a littoral species found attached to aquatic vegetation by a large gland on the back of the head (Goulden, 1964). Quade (1969) found it to be the most abundant cladoceran on aquatic vegetation. Sebestyen (1948) found it to be the most densely occurring cladoceran in Potamogeton stands, but commonly present in lower numbers in all other beds of aquatic vegetation. From my Ottawa River data I would concur with these findings.

3.1.9 Latona setifera

Latona setifera did not appear regularly at any site. Of the samples analyzed, it appeared in less than five percent. Ten of the samples containing L. setifera were taken in the months of September and October and these included the samples having the highest density reported for the animal. L. setifera, like Sida crystallina, appeared more often in samples low in other Cladocera species. It was not reported from the Kettle Island Bay habitat, but was present in all other habitats. It most commonly occurred at the Lower Duck Island stations.

Bigelow (1922) found Latona setifera among aquatic vegetation, but stated that it was never abundant. This was also the case for the Ottawa River. In 1928 Bigelow reportedly found it associated only with the ooze film coenosis. Davis (1972b) stated that he found it in deep samples and that its natural habitat was benthic. Davis (pers. commun.) did not mean to imply that this precluded any possible association with benthic plants. Ottawa River data suggested that the species was most often found in shallow waters, but this might be a condition inherent to rivers, unlike Davis' (1972b) study area.

My Ottawa River data suggests that L. setifera preferred areas where aquatic vegetation existed and was decomposing.

3.1.10 Latonopsis occidentalis

Latonopsis occidentalis was collected in four samples. Two of these samples were mid channel samples, a third was from within the Kettle Island Bay, and the fourth was from station nine. All were low density records for the species.

Both Brooks (1959) and Bigelow (1922) reported L. occidentalis as frequenting weedy pools, however, in the Ottawa River L. occidentalis was found in areas without aquatic vegetation. This would appear to conflict with the findings of Brooks (1959) and Bigelow (1922).

Although Bigelow (1922) included the species in his faunal list of Southern Ontario, Brandlova et al. (1972) in a more recent survey of Ontario have not included it in theirs.

3.1.11 Latona parviremis

A single specimen of Latona parviremis was collected on 2 October 1972 from the Kettle Island Bay area. This was the only record for Latona in the Kettle Island Bay and the only specimen of this species collected.

This would appear to be the first record for the species in Ontario as it was not listed for Ontario by Brandlova et al. (1972). Brooks (1959), however, has reported the species from North America.

3.1.12 Holopedium gibberum

Holopedium gibberum was collected from all habitats. It never reached high densities vis à vis those attained for *Bosmina longirostris*, nor was it consistently represented in sequential temporal samples at any one station. It was taken more often in areas outside of dense aquatic vegetation. Specimens both with and without the gelatinous carapace were collected.

Hamilton (1958) reported *H. gibberum* to be an open water thermophilic species not commonly found among vegetation. It reportedly disappeared from the plankton when temperatures dropped below 12 degrees Centigrade. Within the Ottawa River the distribution of *H. gibberum* appears to support Hamilton's (1958) findings. It was collected only during the summer months.

3.1.13 *Polyphemus pediculus*

Only small specimens of *Polyphemus pediculus* were collected in the Ottawa River although specimens were taken from all of the habitats. Numbers were low (mean value of 7.5 individuals per cubic meter) and most often collected in areas adjacent to aquatic vegetation.

P. pediculus has been reported from margins of lakes and in small water channels (Goulden, 1964) as well as from marshes and pools (Brooks, 1959). It is a thermophilic species attaining maximum densities during warmer summer months and appearing to avoid both deep and very shallow water conditions (Mardakhaj-Boltovskoj, 1966). While agreeing with these findings my data also suggests that *P. pediculus* favoured areas low in other species of Cladocera as well as being outside of aquatic vegetation.

3.1.14 Graptoleberis testudinaria

Within the study area, Graptoleberis testudinaria was reported from only three habitats. In the Kettle Island Bay its numbers were extremely low when present (less than 10 individuals per cubic meter) and its frequency of appearance in samples was also low, being reported in only two samples. At both the bay mouth sites and the Lower Duck Island sites it was collected more frequently and in higher densities than elsewhere (40.4 individuals per cubic meter).

Quade (1969) has pointed out that G. testudinaria was most often found on the surface of aquatic vegetation where it was collected in large numbers. Fryer (1968) discussed the sophisticated locomotory apparatus of G. testudinaria, pointing out its impressive ability to adhere to a substrate.

Fryer (1968) seems to feel that suitable vegetation as a substrate may be more important than physical and chemical parameters. My data does support G. testudinaria's apparent preference for aquatic vegetation as a substrate.

3.1.15 Leydigia leydigii

Leydigia leydigii was collected in only four samples. All specimens came from shallow water within the main river basin. The highest number of specimens were collected from the Upper Duck Island embayment where densities reached 60.6 individuals per cubic meter on 29 June 1972. Other specimens collected were from stations B3, 25, and nine.

Brooks (1959) reported the species to be commonly found in all parts of North America but always in low numbers. Goulden (1966) stated that it most commonly was found living in soft surface organic mud. Based on the Ottawa River collection data, one can only say that L. leydigii appears to be a shallow water dwelling species.

3.1.16 Scapholeberis kingii

Scapholeberis kingii was collected in only three habitats within the study area. It reached maximum numbers (approximately 40 individuals per cubic meter) in both the Lower Duck Island Bay area as well as in the bay mouth area of Kettle Island.

Quade (1969) reported S. kingii to be commonly associated with areas of high Nuphar variegatum (yellow water lily) density. In the Ottawa River study area this species of macrophyte was not found in great densities.

Brooks (1959) pointed out that S. kingii is a surface swimming animal and Quade (1969) observed it associated with floating aquatic vegetation (Nuphar variegatum). These two observations suggest that floating and emergent vegetation act as 'shade' plants hence influencing habitat selection by the species.

3.1.17 Aloninae

Within the Aloninae family of chydorid cladocerans, three species were collected:

1. Camptocercus rectirostris
2. Acroperus harpae
3. Kurzia latissima

The bay mouth area appeared to be the most popular area for Aloninae. All three species were collected in samples taken in this area. Kurzia latissima was present in a single sample taken June 24, 1972. Both Acroperus harpae and Camptocercus rectirostris were abundant in samples from the same area on numerous occasions.

Camptocercus rectirostris and Acroperus harpae showed similarity in distributional patterns. Camptocercus rectirostris was present in all habitats and Acroperus harpae was absent from only the mid channel habitat. Whereas peak densities for Camptocercus rectirostris were less than for Acroperus harpae, the frequency of appearance for the two species slightly favoured Camptocercus rectirostris (45 appearances for Camptocercus rectirostris, 36 for Acroperus harpae). Camptocercus rectirostris reached maximum numbers at the Duck Island sites while Acroperus harpae reached its highest numbers at the bay mouth area of Kettle Island.

Co-occurrence of the two species occurred in 20 samples. In 44 percent of all samples containing Camptocercus rectirostris, Acroperus harpae was also reported. In 56 percent of all samples containing Acroperus harpae, Camptocercus rectirostris was reported. By applying Fager's Recurrent Group Analysis (Lie et al., 1970),

$$I = \frac{J}{(N_A N_B)^{\frac{1}{2}}} - \frac{1}{2(N_B)^{\frac{1}{2}}}$$

where N_B represents the number of samples containing Camptocercus rectirostris (45) and N_A the number of samples containing *Acroperus harpae* (36) and J the number of samples containing both species (20), it is possible to calculate a measure of distributional similarity (I) for the species. The calculated affinity value (I) of 0.401, according to Fager's formula, does not indicate a significant affinity, as significant affinity occurs in cases where I is greater than 0.5.

According to Goulden (1964) both species are capable of existing in open water habitats as well as among aquatic vegetation, as is the case in the Ottawa River. Sebestyen (1948) reported that for aquatic vegetated habitats, *Acroperus harpae* showed some preference for *Myriophyllum spicatum* and that this preference was indicated by density data for the species and not necessarily by its frequency of appearance. This would suggest that for the Ottawa River the preferred habitat was the bay mouth area of Kettle Island.

Smirnov (1972) has recently reviewed and revised the taxonomy of *Camptocercus rectirostris*. He feels that *C. rectirostris* exhibits several sub genera in North America. In examining *C. rectirostris* specimens collected in the Ottawa River, some morphological variation was noticed among the specimens. This variation appeared in the number of incisors on the back of the carapace but could not be definitely attributed to habitat influence.

3.1.18 *Ophryoxus gracilis*

Ophryoxus gracilis specimens were collected in only two habitats - the Lower Duck Island Bay and the bay mouth area of Kettle Island. The former habitat had both greater densities and frequencies of the species. Five samples contained the species. Three of these were taken in late October, whereas the other two were collected during mid June.

Brooks (1959) reported that O. gracilis was widely distributed in North America and that it preferred to frequent habitats supporting aquatic vegetation. This would appear to be the case in the Ottawa River as both habitats with O. gracilis also supported aquatic vegetation. It is noteworthy that O. gracilis was recorded in samples taken either before or after the higher aquatic vegetation reached its peak of development.

3.1.19 Pleuroxus spp.

Pleuroxus species were reported for slightly more than seven percent of the total samples collected. The number of samples containing Pleuroxus species and the species distribution by habitat are shown in Table 9.

Table 9

Number of samples containing Pleuroxus arranged according to species and habitat, for the Ottawa River.

	HABITAT					
	Kettle Island	Lower Duck	Upper Duck	Main Channel	Bay Mouth	Total
P. trigonellus	1	2	-	-	-	3
P. hastatus	1	1	-	2	4	8
P. procurvus	3	3	-	1	3	10
P. hamulatus	-	-	-	-	1	1
P. denticulatus	2	1	-	-	-	3
P. uncinatus	-	1	-	-	-	1
Total	7	8	0	3	8	26

Three habitats, Kettle Island Bay, the bay mouth area of Kettle Island, and the Lower Duck Island Bay were approximately equal in terms of appearance of Pleuroxus species in samples. Upper Duck Island Bay was the only habitat sampled which failed to record a Pleuroxus specimen. Of all habitats, the Lower Duck Island Bay reported more specimens than any other.

P. procurvus and P. hastatus were the most frequently occurring Pleuroxus species, with P. uncinatus occurring the least frequently. Of the 26 samples containing Pleuroxus specimens, congeneric occurrence was noted only once.

Better than 60 percent of the records for the genus were from shallow water habitats supporting aquatic vegetation. Only Pleuroxus hamulatus reached densities in excess of 50 animals per cubic meter. All other species ranged from 3.0 to 30.0 individuals per cubic meter.

The six Pleuroxus species collected from the Ottawa River along with literature on their ecology are listed in Table 10. Although it would appear that all fall within their reported range, the P. uncinatus record appears to be the first record for this species in Ontario. My Ottawa River collection includes a single specimen.

3.1.20 Disparalona acutirostris

In the Ottawa River, Disparalona acutirostris appeared in nine samples (approximately 2.5% of the total samples), eight of which were taken in the Lower Duck Island Bay.

Table 10

Pleuroxus species collected from the Ottawa River and relevant ecological comments from the literature.

SPECIES	ECOLOGICAL COMMENTS
P. hastatus	Rare in the United States (Brooks, 1959)
P. denticulatus	Common in the U.S. Most often found associated with aquatic vegetation (Brooks, 1959).
P. hamulatus	Found in New England and southern U.S. Thought possibly to be a southern species. Common in pools and among aquatic vegetation (Brooks, 1959)
P. trigonellus	Found over the entire North American continent in low numbers (Brooks, 1959).
P. procurvus	Thought to be a northern species (Brooks, 1959) associated with aquatic vegetation (Smith, 1968).
P. uncinatus	Thought to be a northern species (Brooks, 1959). Reported from Vancouver Island and southern British Columbia by Carl (1940), not reported for Ontario by Brandlova *et al.* (1972).

The only other sample containing D. acutirostris was from the bay mouth area of Kettle Island during early August, when a density of 20.2 individuals per cubic meter was recorded. Of all the cladoceran species collected, D. acutirostris showed the greatest specificity in habitat representation with better than 90 percent of its representation in the samples being from one habitat.

In the Lower Duck Island Bay, D. acutirostris was either absent or appeared in two or three samples on a given sampling day. The species appeared sporadically with individuals being collected 29 June, 8 July, 26 August, and 29 October. Maximum densities were recorded during late June (40.4 individuals per cubic meter). All records for D. acutirostris were in excess of 5.0 individuals per cubic meter.

Brandlova *et al.* (1972) have reported the species from both lakes and marshes in the eastern part of Ontario. The Ottawa River data suggests that the species preferred areas of dense aquatic vegetation associated with a decomposing organic substrate.

3.1.21 Simocephalus spp.

Within the Ottawa River habitats, two species of Simocephalus were collected, S. serrulatus and S. vetulus. In no case was there congeneric occurrence. S. serrulatus was found to be more common than S. vetulus which was collected in only two samples (both horizontal hauls - one in the Kettle Island Bay and the other in the adjacent bay mouth area). Due to the low number of samples containing the genus, the two species are discussed together.

Simocephalus spp. appeared in all habitats. The appearance of Simocephalus spp. in the Ottawa River habitats by month is shown in Table 11. It would appear that the genus was more common in the Kettle Island Bay and the Lower Duck Island Bay habitats than anywhere else.

Table 11

Number of samples containing Simocephalus spp. arranged according to habitat and month, for the Ottawa River.

HABITAT	MONTH						
	May	June	July	Aug.	Sept.	Oct.	TOTAL
Kettle Is.	1	2	1	-	1	-	5
Main Channel	-	-	-	1	-	-	1
Bay Mouth area	1	-	1	-	-	-	2
Lower Duck Is.	ns*	1	2	1	-	-	4
Upper Duck Is.	ns*	-	-	-	-	1	1
Totals	2	3	4	2	1	1	

*ns - no samples.

Of the 13 samples containing Simocephalus spp., four were surface horizontal hauls. In the nine vertical hauls, six contained Simocephalus spp. in concentrations of less than five individuals per cubic meter. As described by other authors (Brooks, 1959; Quade, 1969; Sebestyen, 1948; Smith, 1968) the genus is most often found in low densities. Both of the Simocephalus species collected appear to prefer littoral conditions as pointed out by other workers and substantiated by data from the Ottawa River.

3.1.22 Ilyocryptus spp.

Three habitats contained Ilyocryptus species (5 samples). The bay mouth area had two records, one of which was the highest density (15.8 individuals per cubic meter) record for the Ottawa River. Two other records were from station nine immediately upstream of the Kettle Island Bay. The fifth sample was collected from Lower Duck Island Bay. All specimens were identified as I. spinifer except one which was damaged.

In the Ottawa River, I. spinifer appears to be a low density species found infrequently. As Goulden (1964) reported, it appears to be benthic in nature and associated with shallow water areas.

3.1.23 Chydorus spp.

Chydorus species posed identification problems and were left at the generic level as discussed earlier.

In the Ottawa River, Chydorus spp. were collected from all habitats. The monthly distribution of Chydorus by habitat is indicated in Table 12.

The highest densities and frequencies of Chydorus spp. appeared at the Lower Duck Island sites, B1 and B2. This area accounted for almost 40 percent of all Chydorus spp. records in the Ottawa River study area. The bay mouth area of Kettle Island was the second most frequented area (approximately 20% of all records) but densities of Chydorus

Table 12

Number of samples containing <u>Chydorus spp</u>. arranged according to habitat and month for the Ottawa River.

HABITAT	MONTH					
	May	June	July	August	Sept.	October
Kettle Is.	2	5	1	1	1	3
Main Channel	1	1	1	3	2	1
Lower Duck Is.	ns*	8	6	6	6	4
Upper Duck Is.	ns	2	1	2	3	2
Bay Mouth area	-	2	4	7	1	2
Totals	3	18	13	19	13	12

*ns - no samples

spp. in this habitat were much lower than those of Lower Duck Island Bay. The three remaining areas sampled were approximately equal in frequency of *Chydorus spp.* appearance, but densities were lower for the Kettle Island Bay and the main channel habitats.

Generally speaking, *Chydorus spp.* are cosmopolitan and some are considered to be very ubiquitous (Brooks, 1959). Although *Chydorus spp.* are capable of surviving in the open plankton, they appear to be littoral in preference.

3.1.24 miscellaneous species

Some species were collected in only one or two samples and due to lack of data can only be reported as being present. Those species so collected are listed in Table 13. Included are several species discussed elsewhere and here included only for continuity.

Table 13

Species of Cladocera collected infrequently and in low numbers from the Ottawa River.

SPECIES	COLLECTION DATE	HABITAT
Monospilus dispar	20 July	Bay mouth
Streblocercus serricaudatus	26 August	Main Channel
**Latona parviremis*	2 October	Kettle Is.
**Daphnia dubia*	8 July	Lower Duck Is.
**Pleuroxus uncinatus*	19 June	Lower Duck Is.
Alonella excisa	19 October	Kettle Is.
**Alona costata*	13,22 May	Kettle Is.
**Daphnia longiremis*	12 June	Kettle Is.

* species discussed elsewhere in text

3.2 SUMMARY OF HABITAT PREFERENCES

Based upon data collected from the Ottawa River it is possible to arrange cladoceran species according to their apparent habitat preferences (Table 14). Since such an arrangement is dependent upon repetition of the species in subsequent samples, those species collected infrequently and in low numbers are not included.

The most noticeable observation from such an arrangement is that few species appear restricted to a single habitat. Generally the open water species were not commonly found among aquatic vegetation but often were found in areas proximal to dense aquatic vegetation. Similarly those species most abundantly found in aquatic vegetation were poorly represented in open water habitats. Whereas open water species did poorly as benthic dwellers, species living on aquatic vegetation appeared capable of existing as benthic dwellers.

Water current is probably the most influencing feature of river ecosystems. As such it is capable of moving organisms living in one habitat into a completely different habitat. For an organism to survive under such conditions it must either be extremely motile or extremely adaptable. For Cladocera, organisms generally lacking in locomotory abilities, adaptability appears to be the case in the Ottawa River since no commonly reported species appearred habitat restricted.

Table 14

Cladocera species collected from the Ottawa River arranged according to their apparent habitat preferences. (a - habitat prefered; b - habitat suitable; c - species existing in low numbers)

SPECIES	HABITAT* 1.	2.	3.	4.
Bosmina longirostris	a		b	
Eurycercus lamellatus	c	a	b	b
Camptocercus rectirostris		b	b	a
Acroperus harpae		b	a	b
Alona affinis		b	a	b
Sida crystallina		a	c	
Latona setifera		b	b	b
Diaphanosoma spp.	a		b	
Holopedium gibberum	a		b	
Leptodora kindtii	a			
Polyphemus pediculus	a		b	
Daphnia ambigua	a			
Daphnia paryula	a			
Daphnia retrocurva	a		b	
Scapholeberis kingii		a	b	
Simocephalus spp.	b		b	
Leydigia leydigii				a
Ophryoxus gracilis	b		a	
Disparalona acutirostris		b		b
Ilyocryptus spp.				a
Pleuroxus hastatus		b	b	b
Pleuroxus hamulatus		a		
Pleuroxus procurvus	c	b	a	b
Pleuroxus trigonellus			b	
Graptoleberis testudinaria		a		c
Ceriodaphnia ssp.	a		b	

* HABITAT TYPES

1. Open water
2. In aquatic vegetation
3. Near outer fringe of aquatic vegetation
4. Benthic

3.3 COMPARISON WITH OTHER COLLECTIONS

Within the literature there are numerous records of crustacean collections. A few would include; Pennak, 1957; Pennak, 1966; Armitage and Smith, 1968; Armitage and Davis, 1967; Anderson, 1971; Davis, 1972a, 1972b; Carter, 1971; Brandlova et al., 1972; Carl, 1940; Smith, 1968; Applegate and Mullin, 1967; Rybak and Rybak, 1964. These collections are from a wide variety of limnological conditions including limnetic and littoral zones in lakes, ponds, and rivers.

In Colorado, Pennak (1957) examined the limnetic areas of 27 different lakes and reported only nine species of Cladocera. He felt that, in general, neither latitude nor altitude influenced the number of species present in limnetic habitats. He maintained that for his study area, the general limnetic cladoceran population was composed of one to two species only. Applegate and Mullin (1967) examined two different reservoirs and found a total of 14 species of cladocerans. They commented that outside of Colorado, limnetic cladoceran populations tended to contain two to four species and that in Sweden, the extreme occurred with populations ranging from two to eight.

From my Ottawa River data, it would appear that the only limnetic habitat (Kettle Island Bay) tended to be most similar to the Swedish condition in terms of number of cladoceran species present at any one time. On numerous occassions, I collected three species of *Daphnia* in addition to *Bosmina longirostris*, *Ceriodaphnia spp.*, and *Leptodora kindtii*. On occassion, samples also contained *Diaphanosoma spp.* and/or *Holopedium gibberum*. Some limnetic samples have contained up to nine different species of Cladocera, although most often seven were present.

Davis (1972b) reported only six species of Cladocera from Hogan's Pond in Newfoundland. Rybak and Rybak (1964) found 34 species of Crustacea (including Copepoda) in 37 Polish lakes during an examination of crustacean populations in different littoral zone types. In a survey of the Delta Marsh in Manitoba, Smith (1968) collected 26 different cladoceran species. Armitage and Davis (1967) reported only eight cladoceran species from their ponds in Kansas. Anderson (1971) collected 18 species in 146 alpine and subalpine lakes of western Canada. All of these records are well below the 45 cladocerans collected from the Ottawa River during this survey.

There are records of more species of Cladocera in single collections than I was able to collect. However, these are generally for larger geographic areas. For Ontario, 78 species of Cladocera have been reported in a recent survey (Brandlova *et al.*, 1972). While this survey included most of the province of Ontario, mine included only a two kilometer section of the Ottawa River. For British Columbia, Carl (1940) has reported 55 species from a survey which covered most of the province. Of these 55 species, six were *Ceriodaphnia spp.* - a genus I did not identify to species, the two species of Diaphanosoma as listed in Brooks (1959) were recognized, and six were species not listed in Brooks (1959). Besides these points, Carl's (1940) sampling area was also many times larger than was mine. Pennak (1966) pointed out that, upon occassion, European collections have included 50 or more species, however, Applegate and Mullin (1967) have pointed out that the European fauna is richer in Cladocera than is the North American.

It would appear that either the Ottawa River is unique in its cladoceran fauna, or that river habitats present a much wider range of habitat types. I suspect that had efforts been made to collect benthic dwelling Cladocera, probably there would have been many additions made to my species list.

Berg (1943) examined backwaters, littoral zone, and mid-river sites on the River Sussa, but was able to collect only 35 species of Cladocera. His collection contained slightly more than 50 percent of the known cladoceran species in Denmark - which at that time was 64 or 65. My Ottawa River collection included approximately 55 percent of the known species of Cladocera in Ontario. It would appear that the two collections are very close in terms of percentage of native fauna collected. This would appear to support an earlier speculation that rivers present a much wider range of habitat types than do other freshwater bodies.

3.4 ABUNDANCE AND FREQUENCY GROUPINGS

From the samples collected and analyzed, the abundance of a particular species within a sample was available. Similarly the regularity of appearance (frequency) of a species in the samples was also available. By organizing this material according to habitat 'type' it was possible to obtain information on the frequency and density of particular species for the specific habitats sampled.

Species were arranged according to their reported abundance in specific habitats (Table 15). Three abundance groups were recognized; abundant, moderate, and trace. The abundant group included species which were collected in densities of greater than 50 individuals per cubic meter. The moderate group included species collected in densities of less than 50 individuals per cubic meter but greater than 5.0 individuals per cubic meter. Trace species were considered to be any species occurring in densities of less than five individuals per cubic meter.

From Table 15 it would appear that the main channel sites were characterized by the presence of species in moderate abundance. All four of the other habitat 'types' reported two or more species which were considered as abundant. Of these four, the Lower Duck Island Bay area reported the fewest number of abundant group species.

Four of the six habitats considered reported 16 or more species in moderate abundance. Two areas, the Lower Duck Island Bay area and the shallow stations of the main channel,

Table 15. Abundance groups, by habitat, for Cladocera collected from the Ottawa River

HABITAT	ABUNDANT	MODERATE	TRACE
Kettle Island	*Bosmina longirostris* *Daphnia retrocurva* *Daphnia parvula* *Daphnia ambigua* *Diaphanosoma spp.* *Leptodora kindtii* *Ceriodaphnia spp.* *Eurycercus lamellatus* *Daphnia pulex* *Daphnia longiremis*	*Holopedium gibberum* *Alona affinis* *Camptocercus rectirostris* *Simocephalus spp.* *Chydorus spp.* *Polyphemus pediculus* *Pleuroxus trigonellus* *Pleuroxus procurvus* *Pleuroxus denticulatus* *Pleuroxus hastatus* *Sida crystallina* *Alona quadrangularis* *Acroperus harpae* *Graptoleberis testudinaria* *Scapholeberis kingii* *Alona costata*	*Alonella excisa* *Latona parviremis* *Latonopsis occidentalis*
Bay mouth	*Bosmina longirostris* *Daphnia parvula* *Diaphanosoma spp.* *Sida crystallina* *Camptocercus rectirostris* *Acroperus harpae* *Alona affinis* *Eurycercus lamellatus* *Graptoleberis testudinaria* *Leptodora kindtii* *Pleuroxus hamulatus*	*Ceriodaphnia spp.* *Daphnia retrocurva* *Holopedium gibberum* *Chydorus spp.* *Polyphemus pediculus* *Leydigia Leydigii* *Pleuroxus hastatus* *Pleuroxus procurvus* *Simocephalus spp.* *Daphnia ambigua* *Ophryoxus gracilis* *Latona setifera* *Alona quadrangularis* *Alona guttata* *Scapholeberis kingii* *Ilyocryptus spinifer* *Disparalona acutirostris*	*Kurzia latissima* *Monospilus dispar*
Lower Duck Bay	*Bosmina longirostris* *Alona affinis* *Sida crystallina* *Chydorus spp.* *Graptoleberis testudinaria* *Latona setifera* *Camptocercus rectirostris*	*Ceriodaphnia spp.* *Eurycercus lamellatus* *Holopedium gibberum* *Acroperus harpae* *Diaphanosoma spp.* *Disparalona acutirostris* *Polyphemus pediculus* *Alona quadrangularis* *Leptodora kindtii* *Pleuroxus trigonellus* *Ophryoxus gracilis* *Pleuroxus procurvus* *Pleuroxus hastatus* *Pleuroxus denticulatus* *Simocephalus spp.* *Daphnia retrocurva* *Alona guttuta* *Leydigia leydigii* *Illyocryptus spinifer* *Scapholeberis kingii*	*Daphnia dubia* *Pleuroxus uncinatus*
Upper Duck Bay	*Bosmina longirostris* *Camptocercus rectirostris* *Chydorus spp.* *Eurycercus lamellatus* *Sida crystallina* *Alona affinis* *Ceriodaphnia spp.* *Leydigia leydigii* *Daphnia galeata mendotae*	*Simocephalus spp.* *Holopedium gibberum* *Diapanosoma spp.* *Polyphemus pediculus* *Latona setifera* *Acroperus harpae* *Daphnia retrocurva*	
Mid Channel (B6 & 10)	*Bosmina longirostris*	*Daphnia retrocurva* *Holopedium gibberum* *Chydorus spp.* *Sida crystallina* *Diaphanosoma spp.* *Polyphemus pediculus* *Daphnia parvula*	*Latonopsis occidentalis* *Streblocercus serricaudatu*

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		Soapholeberis kingii Alona costata	
Bay mouth	Bosmina longirostris Daphnia parvula Diaphanosoma spp. Sida crystallina Camptocercus rectirostris Acroperus harpae Alona affinis Eurycercus lamellatus Graptoleberis testudinaria Leptodora kindtii Pleuroxus hamulatus	Ceriodaphnia spp. Daphnia retrocurva Holopedium gibberum Chydorus spp. Polyphemus pediculus Leydigia Leydigii Pleuroxus hastatus Pleuroxus procurvus Simocephalus spp. Daphnia ambigua Ophryoxus gracilis Latona setifera Alona quadrangularis Alona guttata Scapholeberis kingii Ilyocryptus spinifer Disparalona acutirostris	Kurzia latissima Monospilus dispar
Lower Duck Bay	Bosmina longirostris Alona affinis Sida crystallina Chydorus spp. Graptoleberis testudinaria Latona setifera Camptocercus rectirostris	Ceriodaphnia spp. Eurycercus lamellatus Holopedium gibberum Acroperus harpae Diaphanosoma spp. Disparalona acutirostris Polyphemus pediculus Alona quadrangularis Leptodora kindtii Pleuroxus trigonellus Ophryoxus gracilis Pleuroxus procurvus Pleuroxus hastatus Pleuroxus denticulatus Simocephalus spp. Daphnia retrocurva Alona guttuta Leydigia leydigii Ilyocryptus spinifer Scapholeberis kingii	Daphnia dubia Pleuroxus uncinatus
Upper Duck Bay	Bosmina longirostris Camptocercus rectirostris Chydorus spp. Eurycercus lamellatus Sida crystallina Alona affinis Ceriodaphnia spp. Leydigia leydigii Daphnia galeata mendotae	Simocephalus spp. Holopedium gibberum Diaphanosoma spp. Polyphemus pediculus Latona setifera Acroperus harpae Daphnia retrocurva	
Mid Channel (B6 & 10)	Bosmina longirostris	Daphnia retrocurva Holopedium gibberum Chydorus spp. Sida crystallina Diaphanosoma spp. Polyphemus pediculus Daphnia parvula Daphnia ambigua Leptodora kindtii Alona affinis Pleuroxus hastatus Camptocercus rectirostris Latona setifera Eurycercus lamellatus Alona costata Pleuroxus procurvus Simocephalus spp. Ceriodaphnia spp.	Latonopsis occidentalis Streblocercus serricaudatus
Shallow water (9 & 11)	Bosmina longirostris Daphnia retrocurva Alona affinis	Chydorus spp. Holopedium gibberum Sida crystallina Polyphemus pediculus Eurycercus lamellatus Leptodora kindtii Leydigia leydigii Acroperus harpae Camptocercus rectirostris Ceriodaphnia spp. Latona setifera Ilyocryptus spinifer Diaphanosoma spp.	Latonopsis occidentalis

were less rich in moderately abundant species.

Only the Upper Duck Island Bay area failed to report a species in trace abundance. It is interesting to note that of all species collected in this study, the trace species were the only species appearing to be habitat specific.

Considering the abundant species, two points appear striking. Firstly, Bosmina longirostris qualified as an abundant species for all habitats examined. Secondly, based solely upon the abundant species, cladoceran communities could be subdivided into three groups. The Kettle Island Bay abundant species community showed little similarity to any other habitat community. All abundant group species collected from Kettle Island were true plankton species, unlike the communities in other habitats. The second community type was the main channel where abundant species were poorly represented. The third community type included both the bay mouth area of Kettle Island and the two Duck Island areas. Here communities of abundant group species were composed of a mixture of both planktonic and non-planktonic cladoceran species.

There was no distinct division of habitats for moderate group communities as appeared with the abundant species data. The Upper Duck Island Bay habitat appeared less rich in moderate group species than any of the other habitats.

In Table 16, species have been arranged according to their reported frequency of appearance within the samples.

Table 16. Frequency groups, by habitat, for Cladocera collected from the Ottawa River

HABITAT	REGULAR	SEMI-REGULAR	IRREGULAR
Kettle Island	*Bosmina longirostris*	*Daphnia* *Daphnia ambigua* *Daphnia parvula* *Diaphanosoma* spp. *Leptodora kindtii* *Ceriodaphnia* spp. *Eurycercus lamellatus* *Holopedium gibberum* *Camptocercus rectirostris* *Simocephalus* spp. *Chydorus* spp.	*Daphnia pulex* *Daphnia longiremis* *Polyphemus pediculus* *Pleuroxus trigonellus* *Pleuroxus procurvus* *Pleuroxus denticulatus* *Pleuroxus hastatus* *Sida crystallina* *Alona affinis* *Alona quadrangularis* *Acroperus harpae* *Graptoleberis testudinaria* *Scapholeberis kingii* *Alonella excisa* *Alona costata* *Latonopsis occidentalis* *Alona rectangula* *Latona parviremis*
Bay mouth	*Bosmina longirostris*	*Daphnia parvula* *Diaphanosoma* spp. *Sida crystallina* *Camptocercus rectirostris* *Acroperus harpae* *Alona affinis* *Eurycercus lamellatus* *Ceriodaphnia* spp. *Daphnia retrocurva* *Holopedium gibberum* *Chydorus* spp.	*Graptoleberis testudinaria* *Leptodora kindtii* *Pleuroxus hamulatus* *Polyphemus pediculus* *Leydigia leydigii* *Pleuroxus hastatus* *Pleuroxus procurvus* *Simocephalus* spp. *Daphnia ambigua* *Ophryoxus gracilis* *Latona setifera* *Alona quadrangularis* *Alona guttata* *Scapholeberis kingii* *Ilyocryptus spinifer* *Disparalona acutirostris* *Kurzia latissima* *Monospilus dispar*
Lower Duck Bay		*Bosmina longirostris* *Alona affinis* *Sida crystallina* *Chydorus* spp. *Graptoleberis testudinaria* *Ceriodaphnia* spp. *Eurycercus lamellatus* *Holopedium gibberum* *Acroperus harpae* *Diaphanosoma* spp. *Disparalona acutirostris*	*Latona setifer* *Camptocercus rectirostris* *Polyphemus pediculus* *Alona quadrangularis* *Leptodora kindtii* *Pleuroxus trigonellus* *Pleuroxus procurvus* *Pleuroxus hastatus* *Pleuroxus denticulatus* *Simocephalus* spp. *Daphnia retrocurva* *Alona guttata* *Leydigia leydigii* *Ilyocryptus spinifer* *Scapholeberis kingii* *Ophryoxus gracilis* *Daphnia dubia* *Pleuroxus uncinatus*
Upper Duck Bay		*Bosmina longirostris* *Camptocercus rectirostris* *Chydorus* spp. *Eurycercus lamellatus* *Sida crystallina* *Holopedium gibberum* *Diaphanosoma* spp.	*Alona affinis* *Ceriodaphnia* spp. *Leydigia leydigii* *Daphnia galeata mendotae* *Polyphemus pediculus* *Latona setifera* *Acroperus harpae* *Daphnia retrocurva* *Simocephalus* spp.
Mid Channel (36 & 10)	*Bosmina longirostris*	*Daphnia retrocurva* *Holopedium gibberum* *Chydorus* spp. *Sida crystallina* *Diaphanosoma* spp.	*Polyphemus pediculus* *Daphnia parvula* *Daphnia ambigua* *Leptodora kindtii* *Alona affinis* *Pleuroxus hastatus* *Camptocercus rectirostris* *Latona setifera*

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			Graptoleberis testudinaria Scapholeberis kingii Alonella excisa Alona costata Latonopsis occidentalis Alona rectangula Latona parviremis
Bay mouth	*Bosmina longirostris*	*Daphnia parvula* *Diaphanosoma spp.* *Sida crystallina* *Camptocercus rectirostris* *Acroperus harpae* *Alona affinis* *Eurycercus lamellatus* *Ceriodaphnia spp.* *Daphnia retrocurva* *Holopedium gibberum* *Chydorus spp.*	*Graptoleberis testudinaria* *Leptodora kindtii* *Pleuroxus hamulatus* *Polyphemus pediculus* *Leydigia leydigii* *Pleuroxus hastatus* *Pleuroxus procurvus* *Simocephalus spp.* *Daphnia ambigua* *Ophryoxus gracilis* *Latona setifera* *Alona quadrangularis* *Alona guttata* *Scapholeberis kingii* *Ilyocryptus spinifer* *Disparalona acutirostris* *Kurzia latissima* *Monospilus dispar*
Lower Duck Bay		*Bosmina longirostris* *Alona affinis* *Sida crystallina* *Chydorus spp.* *Graptoleberis testudinaria* *Ceriodaphnia spp.* *Eurycercus lamellatus* *Holopedium gibberum* *Acroperus harpae* *Diaphanosoma spp.* *Disparalona acutirostris*	*Latona setifer* *Camptocercus rectirostris* *Polyphemus pediculus* *Alona quadrangularis* *Leptodora kindtii* *Pleuroxus trigonellus* *Pleuroxus procurvus* *Pleuroxus hastatus* *Pleuroxus denticulatus* *Simocephalus spp.* *Daphnia retrocurva* *Alona guttata* *Leydigia leydigii* *Ilyocryptus spinifer* *Scapholeberis kingii* *Ophryoxus gracilis* *Daphnia dubia* *Pleuroxus uncinatus*
Upper Duck Bay		*Bosmina longirostris* *Camptocercus rectirostris* *Chydorus spp.* *Eurycercus lamellatus* *Sida crystallina* *Holopedium gibberum* *Diaphanosoma spp.*	*Alona affinis* *Ceriodaphnia spp.* *Leydigia leydigii* *Daphnia galeata mendotae* *Polyphemus pediculus* *Latona setifera* *Acroperus harpae* *Daphnia retrocurva* *Simocephalus spp.*
Mid Channel (36 & 10)	*Bosmina longirostris*	*Daphnia retrocurva* *Holopedium gibberum* *Chydorus spp.* *Sida crystallina* *Diaphanosoma spp.*	*Polyphemus pediculus* *Daphnia parvula* *Daphnia ambigua* *Leptodora kindtii* *Alona affinis* *Pleuroxus hastatus* *Camptocercus rectirostris* *Latona setifera* *Eurycercus lamellatus* *Alona costata* *Pleuroxus procurvus* *Simocephalus spp.* *Latonopsis occidentalis* *Streblocercus serricaudatus* *Ceriodaphnia spp.*
Shallow Channel (9 & 11)	*Bosmina longirostris*	*Chydorus spp.* *Holopedium gibberum* *Sida crystallina*	*Daphnia retrocurva* *Alona affinis* *Polyphemus pediculus* *Eurycercus lamellatus* *Leptodora kindtii* *Leydigia leydigii* *Acroperus harpae* *Camptocercus rectirostris* *Ceriodaphnia spp.* *Latona setifera* *Ilyocryptus spinifer* *Diaphanosoma spp.* *Latonopsis occidentalis*

As was the case with the abundance groupings, arrangement was by habitat. Three frequency groups were recognized; regular, semi-regular, and irregular. The regular group included those species which appeared in 75 per cent, or more, of all samples taken from any particular habitat. The semi-regular group included those species which appeared in samples on five or more sampling days, but that were in less than 75 per cent of the total samples from any one habitat. 'Sampling days' was used in lieu of samples since appearance in five samples on one sampling day was felt a density measurement rather than a frequency measure. The irregular frequency group included those species not meeting the conditions of either of the other two frequency groups.

As can be seen from Table 16, only one species met the conditions of the regular group, that being Bosmina longirostris. Species, in general, appeared to meet either of the other two frequency groups, semi-regular or irregular.

Examining the semi-regular species within the various habitats, it appeared that the Kettle Island Bay was again the exception. Its community included cladocerans of semi-regular frequency which tended to be more characteristic of open water plankton. This was not the case for the other habitats.

From a comparison of Tables 15 and 16 it can be seen that approximately half of the species classed as semi-regular, for any particular habitat, were abundance classed as abundant species. The other half were of the moderate abundance class. This suggested that the groups as presented in Tables 15 and 16 could be further broken down by combining the two tables. The combined abundance group data and frequency group data is presented in Table 17.

By way of an example, for a species to be classed as regularly frequent and abundant, that species had to appear in numbers greater than 50 individuals per cubic meter (abundance group - abundant) and in 75 per cent or more of all samples (frequency group - regular) collected in that habitat. From Table 17, it would appear that the greatest number of species were moderately abundant and irregularly frequent. This grouping included species of medium density and low frequency.

It is interesting to note specific species with respect to their location in Table 17. For example, Polyphemus pediculus was reported from all habitats as a moderately abundant and irregularly frequent species. Its distribution within the study area may be considered very consistent. An example of an inconsistent distribution would be Acroperus harpae which appeared in five of the six habitats. Three habitats reported A. harpae as a moderately abundant irregular species, one habitat reported it as an abundant semi-regular species and another habitat as a moderate semi-regular occuring species. The consistent distribution, such as that exhibited by Polyphemus pediculus, appeared to be the exception rather than the rule.

Table 17

Combined abundance groups and frequency groups, by habitat, for Cladocera collected from the Ottawa River

FREQUENCY SPECIES			SEMI-REGULAR FREQUENCY SPECIES			IRREGULAR FREQUENCY SPECIES		
	MOD.	TRACE	ABUNDANT	MODERATE	TRACE	ABUNDANT	MODERATE	TRACE
rostris	-	-	*Daphnia retrocurva* *Daphnia parvula* *Daphnia ambigua* *Diaphanosoma* spp. *Leptodora kindtii* *Ceriodaphnia* spp. *Eurycercus lamellatus*	*Holopedium gibberum* *Camptocercus rectirostris* *Simocephalus* spp. *Chydorus* spp.	-	*Daphnia pulex* *Daphnia longiremis*	*Polyphemus pediculus* *Pleuroxus trigonellus* *Pleuroxus procurvus* *Pleuroxus denticulatus* *Pleuroxus hastatus* *Sida crystallina* *Alona affinis* *Alona quadrangularis* *Acroperus harpae* *Graptoleberis testudinaria* *Scapholeberis kingii* *Alonella excisa* *Alona costata*	*Latonopsis occidentalis* *Latona parviremis*
irostris	-	-	*Daphnia parvula* *Sida crystallina* *Diaphanosoma* spp. *Eurycercus lamellatus* *Acroperus harpae* *Alona affinis* *Camptocercus rectirostris*	*Ceriodaphnia* spp. *Daphnia retrocurva* *Holopedium gibberum* *Chydorus* spp.	-	*Graptoleberis testudinaria* *Leptodora kindtii* *Pleuroxus hamulatus*	*Polyphemus pediculus* *Leydigia leydigii* *Pleuroxus hastatus* *Pleuroxus procurvus* *Simocephalus* spp. *Daphnia ambigua* *Ophryoxus gracilis* *Latona setifera* *Alona quadrangularis* *Alona guttata* *Scapholeberis kingii* *Ilyocryptus spinifer* *Disparalona acutirostris*	*Kurzia latissima* ~~*Monospilus dispar*~~
	-		*Bosmina longirostris* *Alona affinis* *Sida crystallina* *Chydorus* spp. *Ceriodaphnia* spp. *Graptoleberis testudinaria*	*Eurycercus lamellatus* *Holopedium gibberum* *Acroperus harpae* *Diaphanosoma* spp. *Disparalona acutirostris*		*Latona setifera* *Camptocercus rectirostris*	*Polyphemus pediculus* *Leptodora kindtii* *Pleuroxus trigonellus* *Pleuroxus hastatus* *Pleuroxus procurvus* *Pleuroxus denticulatus* *Alona quadrangularis* *Simocephalus* spp. *Daphnia retrocurva* *Alona guttata* *Leydigia leydigii* *Ilyocryptus spinifer* *Scapholeberis kingii* *Ophryoxus gracilis*	*Daphnia dubia* *Pleuroxus uncinatus*
	-	-	*Bosmina longirostris* *Chydorus* spp. *Eurycercus lamellatus* *Sida crystallina* *Camptocercus rectirostris*	*Holopedium gibberum* *Diaphanosoma* spp.	-	*Alona affinis* *Ceriodaphnia* spp. *Leydigia leydigii* *Daphnia galeata mendotae*	*Polyphemus pediculus* *Latona setifera* *Acroperus harpae* *Simocephalus* spp.	
ngirostris	-	-		*Daphnia retrocurva* *Holopedium gibberum* *Chydorus* spp. *Sida crystallina* *Diaphanosoma* spp.			*Polyphemus pediculus* *Daphnia parvula* *Daphnia ambigua* *Leptodora kindtii* *Alona affinis* *Pleuroxus hastatus* *Camptocercus rectirostris* *Latona setifera* *Eurycercus lamellatus* *Alona costata* *Pleuroxus procurvus* *Simocephalus* spp.	*Latonopsis occidentalis* *Streblocerus serricaudatus*
ongirostris	-	-		*Chydorus* spp. *Holopedium gibberum* *Sida crystallina*	-	*Daphnia retrocurva* *Alona affinis*	*Polyphemus pediculus* *Eurycercus lamellatus* *Leptodora kindtii* *Leydigia leydigii* *Acroperus harpae* *Camptocercus rectirostris* *Ceriodaphnia* spp. *Latona setifera* *Ilyocryptus spinifer* *Diaphanosoma* spp.	*Latonopsis occidentalis*

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Table 17

Combined abundance groups and frequency groups, by habitat, for Cladocera collected from the Ottawa River

HABITAT	REGULAR FREQUENCY SPECIES			SEMI-REGULAR FREQUENCY SPECIES			IRREGULAR FREQUENCY SPECIES		
	ABUNDANT	MOD.	TRACE	ABUNDANT	MODERATE	TRACE	ABUNDANT	MODERATE	
Kettle Island	Bosmina longirostris	-	-	Daphnia retrocurva Daphnia parvula Daphnia ambigua Diaphanosoma spp. Leptodora kindtii Ceriodaphnia spp. Eurycercus lamellatus	Holopedium gibberum Camptocercus rectirostris Simocephalus spp. Chydorus spp.	-	Daphnia pulex Daphnia longiremis	Polyphemus pediculus Pleuroxus trigonellus Pleuroxus procurvus Pleuroxus denticulatus Pleuroxus hastatus Sida crystallina Alona affinis Alona quadrangularis Acroperus harpae Graptoleberis testudinaria Scapholeberis kingii Alonella excisa Alona costata	Lato Lato
Bay mouth	Bosmina longirostris	-	-	Daphnia parvula Sida crystallina Diaphanosoma spp. Eurycercus lamellatus Acroperus harpae Alona affinis Camptocercus rectirostris	Ceriodaphnia spp. Daphnia retrocurva Holopedium gibberum Chydorus spp.	-	Graptoleberis testudinaria Leptodora kindtii Pleuroxus hamulatus	Polyphemus pediculus Leydigia leydigii Pleuroxus hastatus Pleuroxus procurvus Simocephalus spp. Daphnia ambigua Ophryoxus gracilis Latona setifera Alona quadrangularis Alona guttata Scapholeberis kingii Ilyocryptus spinifer Disparalona acutirostris	Kurz Mono
Lower Duck		-	-	Bosmina longirostris Alona affinis Sida crystallina Chydorus spp. Ceriodaphnia spp. Graptoleberis testudinaria	Eurycercus lamellatus Holopedium gibberum Acroperus harpae Diaphanosoma spp. Disparalona acutirostris		Latona setifera Camptocercus rectirostris	Polyphemus pediculus Leptodora kindtii Pleuroxus trigonellus Pleuroxus hastatus Pleuroxus procurvus Pleuroxus denticulatus Alona quadrangularis Simocephalus spp. Daphnia retrocurva Alona guttata Leydigia leydigii Ilyocryptus spinifer Scapholeberis kingii Ophryoxus gracilis	Daph Ple
Upper Duck				Bosmina longirostris Chydorus spp. Eurycercus lamellatus Sida crystallina Camptocercus rectirostris	Holopedium gibberum Diaphanosoma spp.		Alona affinis Ceriodaphnia spp. Leydigia leydigii Daphnia galeata mendotae	Polyphemus pediculus Latona setifera Acroperus harpae Simocephalus spp.	
Mid Channel (86 & 10)	Bosmina longirostris				Daphnia retrocurva Holopedium gibberum Chydorus spp. Sida crystallina Diaphanosoma spp.			Polyphemus pediculus Daphnia parvula Daphnia ambigua Leptodora kindtii Alona affinis Pleuroxus hastatus Camptocercus rectirostris Latona setifera Eurycercus lamellatus Alona costata Pleuroxus procurvus Simocephalus spp.	Lat Str
Shallow Channel (9 & 11)	Bosmina longirostris				Chydorus spp. Holopedium gibberum Sida crystallina		Daphnia retrocurva Alona affinis	Polyphemus pediculus Eurycercus lamellatus Leptodora kindtii Leydigia leydigii Acroperus harpae Camptocercus rectirostris Ceriodaphnia spp. Latona setifera Ilyocryptus spinifer Diaphanosoma spp.	Lat

2 of 2

In a very small study area, such as is the case for this Ottawa River study, exhibiting no geographical barriers between habitats, it does not seem unusual that a species should occur in each habitat. The observed variation in frequency and in abundance exhibited by a species in a particular habitat is probably a direct measure of the suitability of that habitat for that species. Therefore the difference in community structure existing for the various habitats was not in the species present but was in their pattern of appearance in the samples.

3.5 HABITAT DIFFERENCES - QUANTITATIVE

Testing to examine for significant differences (P=.05) between habitats on the basis of their cladoceran population size was done using the Mann Whitney U test and the results presented in Table 18.

As shown in Table 18, the Kettle Island Bay cladoceran population was significantly larger (P=.05) than that of any other habitat. The second largest cladoceran population was found in the bay mouth area of the Kettle Island Bay. All other populations were found to be approximately equal in size.

As pointed out earlier, habitats generally contained the same species, however, a species was often found to vary in both abundance and frequency from one habitat to another. Bosmina longirostris was one species reported in both high abundance and frequency and with a consistent representation

Table 18

Results of Mann Whitney U testing for significant differences in total Cladocera present at different habitats sampled on the same sampling day (P=.05).

DATE	HABITATS TESTED	HABITAT HIGHER (P=.05)
12 June	Kettle Is. & Main Channel	Kettle Is.
29 June	Kettle Is. & Lower Duck Is.	Kettle Is.
20 July	Kettle Is. & Bay mouth	Kettle Is.
22 July	Upper Duck & Lower Duck	Upper Duck
22 July	Upper Duck & Bay mouth	nil
22 July	Lower Duck & Bay mouth	Bay mouth
31 July	Kettle Is. & Main Channel	Kettle Is.
3 August	Lower Duck & Bay mouth	Bay mouth
11 August	Lower Duck & Main Channel	nil
11 August	Kettle Is. & Lower Duck	Kettle Is.
26 August	Lower Duck & Upper Duck	nil
21 Sept.	Kettle Is. & Main Channel	Kettle Is.
10 October	Lower Duck & Upper Duck	nil
19 October	Kettle Is. & Main Channel	Kettle Is.

nil indicates no significant difference could be proven at the 95 percent level.

in all samples. Therefore it was selected for examination to see if significant differences (P=.05) did exist at the species level between habitats (Table 19).

Table 19

Results of Mann Whitney U testing for significant differences in Bosmina longirostris present at different habitats sampled on the same sampling day (P=.05).

DATE	HABITATS SAMPLED	HABITAT HIGHER (P=.05)
12 June	Kettle Is. & Main Channel	Kettle Is.
29 June	Kettle Is. & Lower Duck Is.	Kettle Is.
20 July	Kettle Is. & Bay mouth	Kettle Is.
22 July	Upper Duck & Lower Duck	nil
22 July	Upper Duck & Bay mouth	nil
22 July	Lower Duck & Bay mouth	Bay mouth
31 July	Kettle Is, & Main Channel	Kettle Is.
3 August	Lower Duck & Bay mouth	Bay mouth
11 August	Lower Duck & Main Channel	nil
11 August	Kettle Is. & Lower Duck	Kettle Is.
26 August	Lower Duck & Upper Duck	nil
21 Sept.	Kettle Is. & Main Channel	Kettle Is.
10 October	Lower Duck & Upper Duck	nil
19 October	Kettle Is. & Main Channel	Kettle Is.

nil indicates no significant difference could be proven at the 95 percent level.

The Bosmina longirostris results were similar to those obtained for cladoceran testing (Table 18). In only one instance did cladoceran testing not agree with Bosmina longirostris results, and that occurred on 22 July 1972.

For the 22 July samples, further examination of data showed that the difference reported for the cladoceran testing was attributable to chydorid cladocerans. Chydorids were found to be significantly different (P=.05) between the two habitats, with the Upper Duck Island chydorid population being larger than the Lower Duck Island population.

As pointed out earlier, Bosmina longirostris was the only cladoceran species found in high numbers and frequencies for all habitats examined. For this reason its temporal distribution in the various habitats was examined. The temporal data pertaining to Bosmina longirostris is presented in Table 20.

Table 20

Temporal data relating to the maximum numbers reported for Bosmina longirostris from the Ottawa River habitats.

	KETTLE IS.	UPPER DUCK	LOWER DUCK	MAIN CHANNEL
Maximum Numbers (no. per cu.m.)	172,000	820	1960	580
Time of Maximum Numbers	12 June	29 June	19 June	16 July
Duration of 0.5 Density Range (weeks)	5.7	2.5	2.0	3.5

As can be seen, of the habitats examined, Bosmina longirostris first reached its maximum density in Kettle Island Bay. The temporal order of maximum abundance of Bosmina longirostris in a particular habitat was the same as the order for the degree of enclosure of habitats (Kettle Island most enclosed; main channel least enclosed). This would suggest that the more isolated from the main river a habitat was, the earlier that habitat attained its maximum numbers of Bosmina longirostris.

The maximum abundance attained for a species may be but a single isolated instant when sampling happened to coincide with an animal's aggregating in response to a stimulus. Therefore, it is possible that abundances in two different habitats were similar, but were misrepresented by the maximum abundance values for the particular habitats. In an attempt to obtain a better measure of a species' abundance in a habitat, I have developed the statistic, "0.5 Density Range". This statistic is a measure of the length of time a species was found to be in abundances greater than, or equal to, one-half of its maximum reported abundance. I feel that such a statistic allows for the use of species' abundance data, but avoids the problem of using actual numbers which may be influenced by undefined environmental pressures.

From an examination of Table 20, it would appear that the Kettle Island Bay was the preferred habitat for Bosmina longirostris. In this habitat, higher numbers were retained for a longer period of time than elsewhere in the study area. Although the main channel reported a lower maximum abundance for Bosmina longirostris than did any other habitat, the channel was able to maintain its own high numbers for a longer period of time than did either of the Duck Island areas. This might suggest that succession or environmental changes were slower to occur in the main channel than at the Duck Island sites.

DISCUSSION OF HABITAT DIFFERENCES

The habitats examined can be arranged according to their degree of exposure to current. The Kettle Island Bay represents the extreme situation of little, or no current influence whereas the main channel sites represent the other extreme of complete exposure. This exposure ordination is substantiated by both geographical conditions as well as by physical water properties.

As pointed out earlier, the physical boundaries of the areas and the on-shore protection afforded the habitats by terrestrial vegetation offer protection from either, or both, river generated water currents as well as wind generated currents. The more protected habitats, such as the Kettle Island Bay, appear at first glance, isolated from river generated currents. The thermal stratification of waters in the Kettle Island Bay appear to support this conclusion. The main river channel is continually exposed to river generated currents. The intermediate situation occurs at the Duck Island sites with some protection from currents.

Species were not found to be restricted to specific habitats. This appears understandable since the various habitats sampled were not isolated from each other. Furthermore, river current tended to link all the habitats sampled. However, the pattern of appearance of a particular species did reflect habitat differences. The better the habitat for a species, the better that species did in the habitat.

From a quantitative standpoint, the largest cladoceran population occurred in open water habitats where current was reduced. All the other cladoceran populations were found to be approximately equal in terms of size. Similar results were found in analyzing the Bosmina longirostris data collected for the various habitats.

Further analysis of Bosmina longirostris data suggested that the various habitats sampled were at different stages of succession. It would appear that in those stations exposed to water current, succession was behind the more stagnant Kettle Island Bay situation. The B. longirostris population in the Kettle Island Bay was observed to reach maximum numbers earlier than anywhere else in the study area. The main channel stations were the last to show maximizing of B. longirostris numbers.

It is possible that either river current or water temperature was responsible for this delaying of succession. Other possibilities do exist, but these are the most noticeable differences between the exposed to current sites and those sites not exposed.

Although succession appeared delayed within the exposed sites, the duration of the higher B. longirostris abundances was not as clear. The Kettle Island Bay showed the greatest ability for maintaining higher numbers of B. longirostris. After the Kettle Island Bay it appeared that the more exposed a site was to current, the longer it was able to maintain its higher numbers of B. longirostris. This duration of high numbers for exposed sites may be a result of delayed succession. In other words, it took longer for the successional pattern to develop to the next successive stage or species.

Probably the best indication of habitat differences may be seen from the structure of the communities within the various habitats. Generally speaking, each habitat contained approximately the same number of component species. The most noticeable exception would be the Upper Duck Island Bay.

With the exception of the two Duck Islands, all habitats supported the same highly abundant and regularly occurring species, B. longirostris. This species has been previously dealt with and appears to indicate delayed succession.

The semi-regular abundant species, as shown in Table 17, are a dominant part of the cladoceran population from a purely numbers standpoint. This group can be sorted as to habitat preferences per species as discussed earlier.

The Kettle Island Bay abundant semi-regular species included mainly planktonic cladocerans. Species such as Daphnia retrocurva, Daphnia parvula, Ceriodaphnia spp. and Leptodora kindtii are typical of lake and pond habitats. Only one species, Eurycercus lamellatus, included in this group is not traditionally considered planktonic.

Within the Lower Duck Island Bay, the abundant semi-regular species included two species commonly found living on aquatic vegetation. These were Graptoleberis testudinaria and Sida crystallina. Several other abundant semi-regular species in this habitat have been reported capable of doing well in aquatic vegetation. The same habitat reported two of the traditionally planktonic cladocerans, Ceriodaphnia spp. and Bosmina longirostris.

It would appear that those species capable of living free of the benthic substrate and among aquatic vegetation did best in this habitat. Comparatively speaking, benthic dwelling species were collected in higher numbers and more frequently in some of the other habitats.

For the Upper Duck Island abundant semi-regular species, the tendency was for species to be more characteristic of benthic life. Of the species adapted for, and favouring life on aquatic vegetation, only Sida crystallina was present. Several other species collected such as Camptocercus rectirostris and Eurycercus lamellatus, have been reported as doing well in aquatic vegetation, but are more often considered as being benthic. The only true plankton species collected was Bosmina longirostris but it was collected in low numbers compared to its occurrences in other habitats.

The main river channel sites, both mid channel and the shallower areas, failed to report abundant semi-regular species. In these two areas, the dominant community, numberwise, is that of the moderate semi-regular species. Of these species true planktonic species were most typical.

For habitats possessing abundant semi-regular species, the moderate semi-regular community tended to be very similar in terms of species' habitat preferences. In only one case was the moderate semi-regular community unlike the abundant semi-regular community and that being the Upper Duck Island

Bay.

At the Upper Duck Island Bay the moderate semi-regular community contained planktonic species only. These were poorly represented in the abundant semi-regular community.

The irregular frequency species are of little value in terms of measuring habitat suitability or characteristics. Their occurrence may indicate unfavourable environmental conditions or may indicate the influence of recruitment from upstream populations. However, from a comparative habitat analysis standpoint, they are considered of little value.

CONCLUSIONS

In examining the Ottawa River populations of Cladocera, the central portions of the river ecosystem offered the poorest habitat possibilities. Generally mid river populations were reduced in both number of species and abundance of Cladocera. On the other hand, shallow water areas in association with aquatic vegetation were quite rich in species and some species were often found in relatively high numbers.

The major difference between shallow semi-exposed sites and central exposed sites was current. In areas where current was pronounced, a frequently occurring species, particularly Bosmina longirostris, was observed to reach maximum seasonal abundance later than in those areas with reduced current. However, areas having the greatest current appeared to maintain their high abundances for longer periods of time than did habitats partially exposed to current.

Due to the small geographic area sampled and the interconnection of all habitats examined species were not found to be restricted to particular habitats. However, the communities within individual habitats did show differences between the habitats. When river current was completely absent, as in the Kettle Island Bay, the cladoceran population supported primarily planktonic species. Semi-exposed sites, such as the two Duck Island areas tended to support substrate dwelling species. When current was somewhat reduced, as in the Lower Duck Island Bay, the preferred substrate appeared to be vegetation. When current was continually present, the benthic substrate appeared to be preferred.

From a taxonomic standpoint, the study area was found to possess a large number of species. Of the 45 species collected only three were not included in the recent survey of Cladocera in Ontario (Brandlova *et al.*, 1972). Of the three, there are no known records for *Pleuroxus unicinatus* or *Latona parviremis* in Ontario, while *Latonopsis occidentalis* has been reported for Ontario previously (Bigelow, 1922).

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